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Training Program

Module II: Economics of Climate Change

Prepared for:
The United States Agency for International Development
under Contract LAG-I-00-98-00005-00, Task Order 16

Prepared by:
PA Government Services Inc.
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USA
(202) 442-2000

September 2000
Updated September, 2002

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Module Contents

Overview

Background

This module is the second in a series of nine training modules, which comprise the Climate Change Initiative's (CCI) near-term training program in Ukraine. As a complete package, these nine modules are intended to build awareness among a wide group of stakeholders, on climate change issues.

Module Two, *Economics of Climate Change*, is designed to provide an overview of the issues inherent to the assessment of macroeconomic impacts of climate change policies and strategies The course agenda focuses on a review of employment and other macroeconomic benefits of climate protection strategies, as well as a review of the modeling frameworks and approaches for assessing macroeconomic costs and benefits. Materials for this module were adapted from slide presentation materials adapted from existing climate change-related training packages and new materials.

Participation

The ideal audience for this module includes individuals from government energy and economics agencies, and other Ukrainian stakeholder organizations who are interested in understanding the macroeconomic implications of investments in climate change mitigation policies and measures. Other participants with a technical background in economics will also benefit.

Objectives

The objective of the training is to provide Ukrainian professionals with an understanding of the implications to the macro economy from policies and measures that reduce GHG emissions. The sessions are structured to addressed questions such as how can one assess job creation benefits, impact on gross domestic product, and subsector level impact. Understanding these macroeconomic effects depends a great deal on assumptions about technology turnover, data detail, consumer behavior, sectoral interactions, and uncertainty. The training materials imply that the audience is familiar with macroeconomic theory and general macroeconomic modeling approaches. Each of the major topics is covered in the form of presentations by local or international specialists. These topics include:

- Macroeconomic context in Ukraine

- Context for conducting climate change policy assessment
- Methods for assessing climate protection strategies
- Costs & benefits of climate policies and strategies
- Framework for assessing macroeconomic impacts of climate change strategies
- Macroeconomic models for climate change policy analysis
- Case study of modeling structure and assumptions in climate change policy

Module Basics

Duration: 5 days

Participants: up to 50

Venue: Open

Facilities (recommended): The module can be presented in any comfortable training facility. Adequate space for plenary presentations should be available.

Format: Workshop; total of 24 sessions, consisting of a (typically) 30- to 60-minute long presentation, which includes a question and answer period, panel discussions, and a large group working group exercises

Instructors: 1 international specialist, 2-6 Ukrainian specialists

- ***Audio/Visual Needs:*** Overhead projector, overhead monitor, PCs
- ***Contacts:*** Natalya Parasyuk of CCI, Dan Thompson (USAID), Bill Dougherty of Tellus Institute

Materials

The module provides several types of material for use during both the preparation of the workshop, and the workshop itself. This material is outlined below.

Session Overview: The session overviews are “blueprints” for each of the sessions. The overview of each session provides a summary of the session, listing basic information, such as the general objective, total time, and type of activities involved.

Overhead transparencies: OHTs are divided into sets according to sessions. Each set of OHTs is numbered consecutively and has titles based on their

content. The precise order in which slides should be shown is presented in the corresponding Session Overview. Presenters are encouraged to give participants sufficient time to read and understand each OHT. For international presenters, simultaneous translation is recommended.

Reading and Resources: The topic of macroeconomic modeling of climate change policies sand measures has a growing reference library. Selected citations for key reports are included for further reference.

Evaluation Process

Module Two will need be evaluated in order to improve the workshop package for more effective subsequent use. The evaluation can be conducted using a simple questionnaire. At the close of the 5th day, the workshop organizer should ask the participants to take five to ten minutes to complete the evaluation form. Participants need to be asked to put down their names on the forms.

Module References

Materials for this module were adapted from slide presentation materials adapted from: the training package entitled, *Economics of Climate Change*, developed jointly by the Tellus Institute and Alternative Energy Development, on behalf of the International Institute for Education (IIE).

In addition, the training course entitled, “Economics of Environmental Decision-Making” that is run by the USEPA’s Office of International Activities was evaluated as an option to meet the objectives of the Economics of Climate Change training module. The emphases of the EPA course are on provide pragmatic information regarding the design and implementation of incentive measures to reduce air and water pollution and on how incentives can be designed and used with regulatory approaches to more efficiently achieve environmental objectives. As such, its relevance is more closely tied to the concepts in the training module on “Certifiable Climate Change Transactions” which deals at length with the design of market incentives for achieving environmental objectives.

Recommended Agenda

The recommended agenda for Module Two appears on the following page.

Proposed Agenda for Module 2: Economics of Climate Change
Day 1

Session	*Topics to be covered*	*Time*
Registration		9:00 – 9:30
Opening Remarks	Welcome to participants, introduction of meeting structure, overall objectives and presenters	9:30 – 10:00
Video Presentation	Introductory video on the science and impacts of climate change	10:00 – 10:30
1. Introduction to climate change	The process of climate change including greenhouse effect, greenhouse gas sources and sinks, historical record, including Q&A	10:30 – 11:15
Break		11:15 – 11:30
2. Impacts of climate change	Physical changes due to climate change and forecasts of their specific ecological and sectoral impacts	11:30 – 12:15
3. Vulnerability and Adaptation in Ukraine	Vulnerability and Adaptation in Ukraine	12:150 – 12:45
Discussion Session		12:45 – 13:00
Lunch		13:00 – 14:00
4. International agreements on climate change	The international response to the threat of climate change, and the structure, functionality and challenges of international agreements	14:00 – 14:45
5. Current International Negotiating Process	The latest events and the nearest future in the international negotiating process under UN Framework Convention on Climate Change	14:45 – 15:15
Break		15:15 – 15:30
6. Methods of climate change assessment	The series of methodological tools developed for use by nations in assessing a) the significance of climate change to their unique circumstances, b) how they contribute to the problem, and c) what they might do to respond at the national level	15:30 – 16:15
Discussion Session		16:15 – 16: 30
7. Financing and flexibility mechanisms	Opportunities and parameters presented by the international agreements for financing national responses to climate change	16:30 – 17:00
Summary of Day 1		17:00 – 17:15

Day 2

Session	Topics to be covered	Time
Introduction to Day2		9:00 – 9:15
8. Inventory of GHG emissions	Emission sources and greenhouse gases, CO2 emissions and approaches to their calculation	9:15 – 10:00
9. Inventory in Ukraine	GHG Inventory in Ukraine: challenges and needs	10:00 – 10:45
Break		10:45 – 11:00
10. Inventory in Power Sector in Ukraine	GHG Inventory in power Sector in Ukraine: Results CCI Study	11:00 – 11:45
11. Inventory of GHG emissions in the coal sector of Ukraine	Inventory of GHG emissions in the coal sector of Ukraine: PIER Study	11:45 – 12:30
Discussion Session		12:30 – 13:00
Lunch		13:00 – 14:00
12. Introduction to mitigation Analysis	Introduce the basic purpose, structure, and steps involved in mitigation analysis	14:00 – 14:45
13. Key mitigation concepts	Review major factors and steps that need to be considered when preparing a mitigation assessment	14:45 – 15:30
Break		15:30 – 15:45
14. Mitigation Methods	Review main methodological approaches to mitigation	15:45 – 16:15
15. Ukraine's GHG mitigation assessment	Review approach and main findings of Ukraine's existing assessment	16:15 – 16:45
Summary of Day 2		16:45 – 17:00

Day 3

Session	Topics to be covered	Time
Introduction to Day 3		9:30 – 9:45
16. Introduction to market mechanisms in ecology	Introduction to market-based Environmental management	9:45 – 10:30
17. History of Emission Trading in the US and Future Applications	Emission Trading under the Kyoto protocol	10:30 – 11:15
Break		11:15 – 11:30
18. Cooperative Mechanisms of the Kyoto Protocol on Climate Change	New Instruments for Environmental Protection and Technology Transfer	11:30 – 12:30
Discussion Session		12:30 – 13:00
Lunch		13:00 – 14:00
19. Key Points of JI Projects	Joint Implementation under the Kyoto protocol	14:00 – 15:00
Break		15:00 – 15:15
20. Introduction to MERVC Issues	Linkages between MERVC components, main definitions. Monitoring domain, additionality, baseline, free riders, positive project spillover, market transformation	15:15 – 15:45
Panel Discussion		15:45 – 16: 45
Summary of Day 3		16:45 – 17:00

Day 4

Session	Topics to be covered	Time
Introduction to Day 4		9:00 – 9:15
21. Project baselines	What are they and Why Do They Matter?	9:15 – 9:45
22. Methods of baselines definition	How are They Determined?	9:45 – 10: 15
Discussion Session		10: 15 – 10:30
Break		10:30 – 10:45
Introduction to Project-Level Baseline Modeling Exercise	Introduction to Project-Level Baseline Modeling Exercise	10:45 – 11:45
Discussion Session		11:45 – 12:30
Lunch		12:30 – 13:30
Working Group Exercise		13:30 – 15:30
Break		15:30 – 15:45
Discussion of results		15:45 – 16:30
Summary of Day 4		16:30 – 16:45

Day 5

Session	Topics to be covered	Time
Introduction to Day5		9:00 – 9:15
23. Financial & Economic Assessments of Projects (part I)	Provide overview and context: Discuss goals of training, elements of project preparation for JI projects. Discuss unique aspects of JI project investments, Summarize context of JI investments (UNFCCC, Kyoto)	9:15 – 9:45
25. Financial & Economic Assessments of Projects (part II)	Economic and Financial Analysis – Differences between economic and financial analyses; what are investors/lenders looking for? Constructing the Pro Forma or business case for the Investment Project	9:45 – 10: 15
Discussion Session		10: 15 – 10:30
Break		10:30 – 10:45
Introduction to working group excesses	Use of PROFORM computer model in analyzing a specific project	10:45 – 11:45
Working Group Exercise		11:45 – 12:30
Lunch		12:30 – 13:30
Working Group Exercise		13:30 – 15:00
Discussion of results		15:00 – 15:30
Break		15:30 – 15:45
Panel Discussion		15: 45 – 16:30
Closing remarks		16:30 – 16:45

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 1: Introduction to Climate Change

Overview

General Objectives: By the end of the session, participants should have a basic understanding of the following:

- Changes and trends in the historical temperature records
- How changes in the atmosphere affect its behavior
- The causes of these changes
- The physical effects of these changes on the Earth

Activities: An overhead slide presentation, followed by period of questions and answers

Total Time: 45 minutes

Materials: Set of 23 OHTs; One hand-out (Sources of additional information)

Reading and Resources

Where to Find More Information:

- Houghton et al.,1990. *IPCC Scientific Assessment Report,* Cambridge University Press, Cambridge, UK.
- Information Unit on Conventions (IUC), United Nations Environment Programme, Geneva, Switzerland
- Climate Change Secretariat, 1995. Annotated Compilation of Reports by International Agencies on the Risks of Rapid Climate Change, UNFCCC Secretariat, Geneva, INC Doc A/AC.237/83
- Houghton et al., 1996*: Climate Change 1995: The Science of Climate Change*, Cambridge University Press, Cambridge, UK
- Watson, et al., 1996. Climate *Change 1995: Impacts, Adaptations, and Mitigation of Climate Change*, Cambridge University Press, Cambridge, UK.

Introduction to Climate Change

Module 2, Session 1

CCI - Ukraine Workshop Package

Slide 1

The Science of Global Climate Change

Impacts are closely related to science

Session 1 - Intro to climate change
(focus on science)

Session 2 - Impacts of climate change

Session 2 builds on Session 1

Slide 2

Acronyms used in this session

IPCC	- Intergovernmental Panel on Climate Change
GHG	- Greenhouse Gas
CO_2	- Carbon Dioxide
CH_4	- Methane

Slide 3

Session I: Overview

This session will :

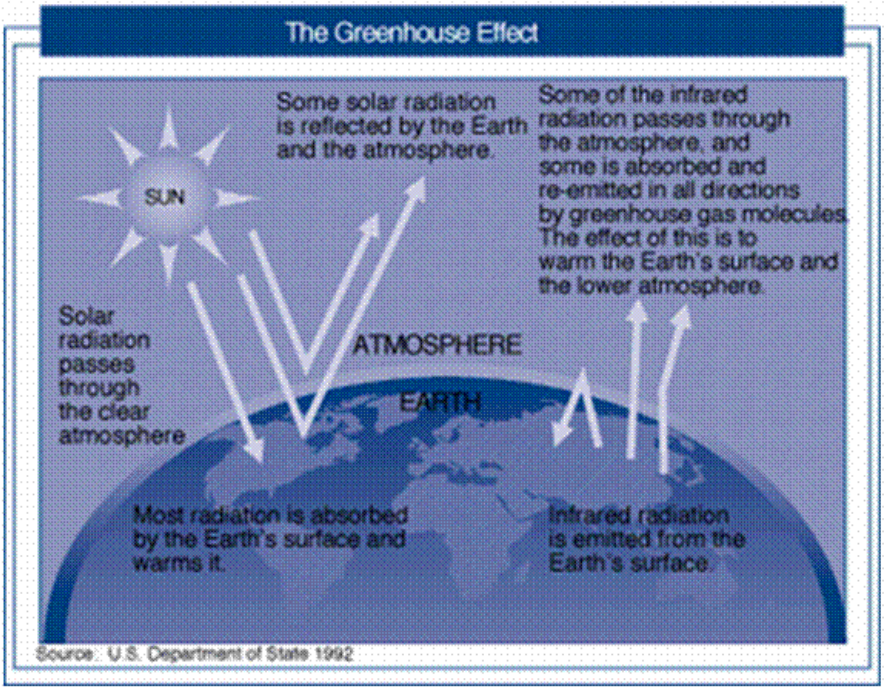
- Review the natural greenhouse effect and how humans are increasing GHG levels
- Examine trends in the historical temperature records
- Summarize the latest IPCC conclusions
- Review major GHG sources and sinks

Slide 4

Key Topics

- The physics of the greenhouse effect
- The observed record of atmospheric temperature and GHG concentration
- Feedbacks and uncertainties in the climate system
- Multiple causes of increased GHG concentrations

Slide 5



Slide 6

Life is possible because of the natural Greenhouse Effect

- The Earth's surface temperature would be only -18° C without the Greenhouse Effect
- The natural greenhouse effect warms the atmospheric temperature to 15° C at the Earth's surface
- This natural warming allows water to exist on the Earth's surface. Water is the basis of life support and biological evolution

Slide 7

Feedback Mechanisms

- Water vapour feedback
- Cloud feedback
- Surface albedo feedback
- Feedback involving oceans
- Feedback effects could bring rapid change

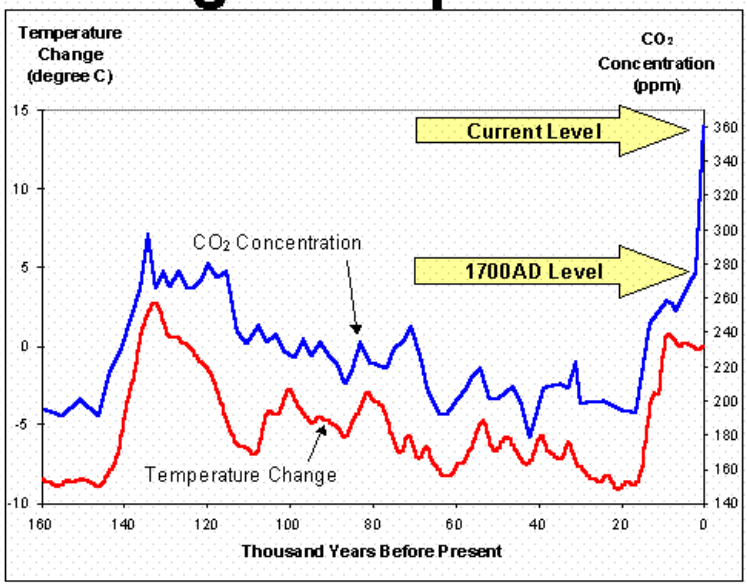
Slide 8

Long-Term Temperature Record

- Change is not unusual. The atmosphere's temperature has always fluctuated in the past over large time-scales (thousands of years).
- Ice core data indicate large temperature swings that are correlated with $C0_2$ and methane concentrations.
- Change is not steady (monotonic) due to the underlying variability of the climate system and positive feedback mechanisms.

Slide 9

Correlation of CO_2 and Average Temperature



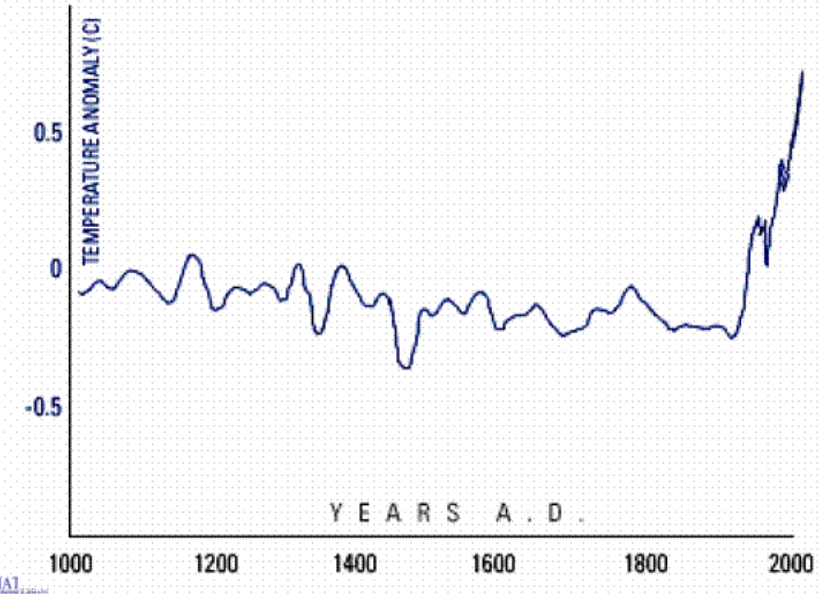
Slide 10

Latest IPCC Conclusions

- Third Assessment Report released in 2001.
- Global average surface temperature has been relatively stable for the past 1000 years
- Temperature has increased about 0.6°C over the last 100 years but with significant year-to-year variation.
- 1990s were warmest decade on record
- 1998 was warmest year on record
- Warming over last 50 years is likely due to increased GHG concentrations.

Slide 11

Average Temperature 1000-2000



Slide 12

Latest IPCC Projections

- By 2100, under a "business as usual" scenario:
  - CO_2 concentrations are expected to increase by 90 - 250% over pre-industrial levels.
  - Large increases in methane and N_2O concentrations are also expected.
  - Global average surface temperatures will increase by 1.4 - 5.8° C.

Slide 13

Latest IPCC Projections [cont.]

- Warming will not be evenly distributed worldwide
- Warming will be greatest at the poles (up to 2-3 times global average) and least in the tropics (50-75% of global average).
- Projections of temperature changes at the regional level are highly uncertain.

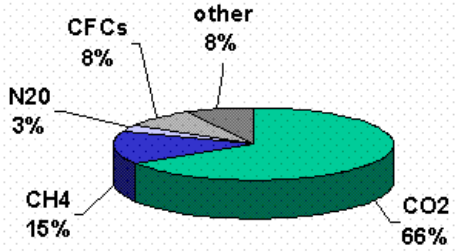
Slide 14

Sources and Sinks of Greenhouse Gases

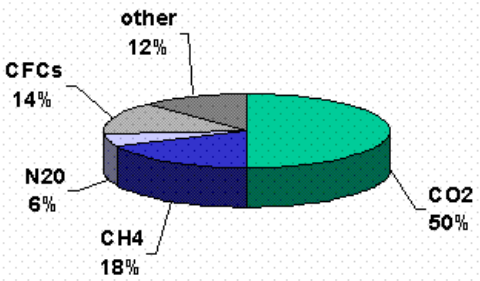
- **Source:** A natural or human activity that emits GHGs into the atmosphere. The most important anthropogenic (human) source of carbon dioxide is fossil-fuel combustion.
- **Sink:** A part of the biosphere that acts as a stable reservoir for GHGs. The most important sinks of carbon dioxide are the oceans and the terrestrial biomass (e.g., trees).
- **Net Emissions = Sources - Sinks**

Slide 15

Many Gases Contribute to Global Warming



1880 - 1980



1980 - 2000

Estimated value based on concentration changes.
Source: 1880 – 1980: Ramanathan et.al., 1985
1980s: Hansen et.al., 1988

Slide 16

Sources of Carbon Dioxide Emissions

- Anthropogenic emissions of CO_2 were roughly equivalent to 6 - 8 billion tonnes of carbon in 1990
- This represents a global average emission rate of slightly more than 1 tonne of carbon per person per year
- The principle source of CO_2 emissions each year include:
  - Emissions from fossil fuel combustion and cement manufacturing: *5.6 billion tonnes of Carbon / yr*
  - Emissions from deforestation and other forms of land-use change: *0.5- 2.5 billion tonnes of Carbon / yr*

Slide 17

Natural Sinks of CO_2

The principal sinks for CO_2 are :

- storage by forests
- absorption in the ocean
- uptake by soils

Slide 18

Sources and Sinks of CH_4

Major Natural Sources

- Wetlands, termites

Major Human Sources

- Rice paddies, livestock,
- Natural gas production and transmission
- Landfills, coal mining

Slide 19

Sources of Other GHGs

- Methane (CH_4)
- Nitrous oxide is produced by bacteria in soils
- CFCs are produced only by industrial processes
- Tropospheric ozone is produced by the interaction of sunlight with other industrial pollutants *(e.g., nitrogen oxides (NOx) and volatile organic compounds (VOCs).*

Slide 20

Reduction in GHG Emissions Needed to Stabilise Atmospheric Concentrations at Present Levels

Greenhouse Gas:	Reduction Required:
– Carbon Dioxide	>60%
– Methane	15 - 20%
– Nitrous Oxide	70 - 80%
– CFC-11	70 - 75%
– CFC-12	75 - 85%
– HCFC-22	40 - 50%

Slide 21

Summary

- The greenhouse effect is a natural process, necessary to maintain life on this planet.
- Climate change has become a threat because of excess anthropogenic emissions of GHGs.
- If current emissions trends continue, atmospheric build-up of greenhouse gases could cause average temperatures to increase significantly over the next century.
- Although CO2 is the most important GHG, several other gases make significant contributions
- Very large decreases in GHG emissions are needed in the long run to stabilize GHG concentrations.

Slide 22

Where To Get More Information

- Intergovernmental Panel on Climate Change. Third Assessment Report (2001) and earlier publications. <www.ipcc.ch>
- World Meteorological Organization. <www.wmo.ch>
- U.S. Environmental Protection Agency. Climate change website. <www.epa.gov/globalwarming>
- U.S. Global Change Research Program. <www.usgcrp.gov>

Slide 23

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 2: The Impacts of Climate Change

Overview

- **General Objectives:**

  By the end of this session, the participants should be able to appreciate the following key issues:

  a) What changes will affect the planet as a whole?
  b) Which changes will affect only certain regions?
  c) How will the regional impacts be distributed?
  d) Will the changes occur gradually or in a step-wise, discontinuous pattern?

  The purpose of this session is to help participants identify and appreciate the potential regional and global impacts of climate change.

- **Activities:** Presentation, followed by period of question and answer
- **Total Time:** 45 minutes
- **Materials:** Set of 23 OHTs

The Impacts of Climate Change

Module 2, Session 2

CCI - Ukraine Workshop Package

Slide 1

Objectives

- Highlight the likely impacts of climate change on physical, human, and ecological systems
- Review possible scenarios of severe impacts
- Explore some potential adaptation strategies

Slide 2

Key Questions

- What are the likely impacts on physical systems (e.g., weather, sea level, glaciers, etc.)?
- What are the likely changes on humans and human systems?
- What are the likely changes on ecosystems?
- How will changes vary by region?
- What will be the impact on Ukraine?

Slide 3

Impacts - Physical Systems - Weather

- The increase an average surface global temperature will have a complex set of impacts on weather patterns.
- Predictions of weather impacts are less certain than the average temperature increase
- Likely impacts include: more droughts in mid-latitude continental interiors, more intense precipitation events, and increased tropical cyclone intensities

Slide 4

Impacts - Physical Systems - Sea Level, Glaciers, Etc.

- Sea level likely to increase 9 to 88 cm. by 2100, and will continue to increase thereafter
- Shrinkage of glaciers
- Thawing of permafrost
- Water bodies: later Winter freeze / earlier Spring thaw

Slide 5

Impacts - Human Systems

- Human health
- Human settlements
- Water Supplies
- Energy & industry
- Agriculture
- Forestry
- Fisheries

Slide 6

Impacts on Human Health

- Warmer weather may alter the habitat and lifecycle of pests and other vectors of disease
- Preliminary data suggests that warmer ocean waters may promote wider exposure to typhoid in coastal areas
- Warm, wet weather may expand the range of malaria-carrying mosquitoes
- Warm weather may increase the spread of dengue fever and river blindness

Slide 7

Impacts on Human Settlements

- The areas most vulnerable to sea level rise are low-lying islands and flat delta regions at the mouths of the great rivers
- Increased landslides are also likely
- Coastal storm surges could threaten 200 million people by 2080
- Estimates of damage to coastal infrastructure are tens of billions of dollars per country (e.g., Egypt, Poland, Vietnam)

Slide 8

Impacts on Water Supplies

- Impacts will depend on changes in regional precipitation patterns
- Currently 1.7 billion people live in "water stressed" regions, and this will grow to 5 billion in 2025
- Climate change is likely to decrease water supplies in many of these areas (e.g., Central Asia, Southern Africa) while increasing supplies elsewhere

Slide 9

Impacts on Energy and Industry

- Warming weather and extended hot spells may decrease water availability for hydropower
- During the California drought of the 1970s, for example, electricity production from hydroelectric dams declined by 30%
- Other industry faces similar risks as human settlements

Slide 10

Impacts on Agriculture

- Impacts are complex and can vary by region and by degree of climate change
- Key factors include regional changes in temperature and precipitation, and adaptation by farmers are all important
- In general, a small warming may improve agricultural yields in mid-latitude regions
- A warming of more than a few degress C. is likely to decrease these yields
- Yields in tropics will generally fall

Slide 11

Impacts on Agriculture [cont.]

- Farmers in regions of traditionally rainfed agriculture may have to alter their cropping patterns or abandon their lands if regional precipitation and runoff increase or decrease dramatically
- In some regions, warmer temperatures may allow lands at higher elevations to be colonized for agriculture
- Some "CO2 fertilization" may occur, but its impact will be small relative to other impacts

Slide 12

Impacts on Forestry

- Like agriculture, impacts on forestry are complex and can vary by region and by degree of climate change
- Impacts are likely to be similar to that of agricultural sector

Slide 13

Impacts on Fisheries

- The impacts of climate change will interact with the effects of overfishing, shrinking nursery areas, and extensive inshore and coastal pollution to threaten many traditional fisheries
- Changes in water temperature may cause some commercially important species to die off or migrate away from traditional fishing grounds
- Warmer water can alter predator-prey relations
- Changes in ocean currents may bring fish populations into contact with new predators or competitors
- The principal impacts will be felt at the national and local level as species mix and habitats shift

Slide 14

Impacts - Ecosystems

- Shifts and declines in various plant & animal species
- Exinction of vulnerable species and decline of biodiversity

Slide 15

Regional Impacts of Climate Change

- Different climate models predict similar global impacts, but can vary in predictions of regional impacts
- Some models may predict that a region may benefit (e.g., slight warming and increased precipitation may help agriculture)

Slide 16

Regional Impacts [cont.]

- An increasingly interconnected and globalized economy make it unlikely that there will be "winners" due to climate change
- Scenarios of severe climate change should also make one cautious of predicting "winners"

Slide 17

Scenarios of Severe Climate Change

- Scientists cannot rule out some scenarios of rapid and severe climate change if:
  - "Ocean conveyor belt" is disrupted
  - Antarctic and Greenland icesheets melt
  - Large GHG releases from melting permafrost or methane in coastal sediments

Slide 18

Impacts - Ukraine

– *[insert any available material specific to Ukraine here. Give range of impacts if possible]*

Slide 19

Summary

– The impacts of rapid climate change will affect many sectors of society and natural ecosystems

– The ability of society and natural ecosystems to adapt to impacts will be strongly affected by the rate at which the change occurs

Slide 20

Summary [cont.]

- Agriculture, forests, and fisheries may experience significant changes in their annual yields
- The fertility, robustness, and species composition of various ecosystems may change dramatically
- Human health may be adversely affected by changes in the range and strength of disease vectors and pests

Slide 21

Summary (cont.)

- The extent of the damage to ecosystems and the dislocation of human economies will be greater if the rate of change is rapid.
- Climate change is likely to occur at the same time as other types of environmental stress. As a result, rapid climate change may magnify these impacts.

Slide 22

Where To Get More Information

- Intergovernmental Panel on Climate Change. Third Assessment Report (2001) and earlier publications. <www.ipcc.ch>
- World Meteorological Organization. <www.wmo.ch>
- U.S. Environmental Protection Agency. Climate change website. <www.epa.gov/globalwarming>
- U.S. Global Change Research Program. <www.usgcrp.gov>

Slide 23

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 3: International Agreements on Climate Change

Overview

- **General Objectives:**
  Session 3 is an introduction to the United Nations Framework Convention on Climate Change and the Kyoto Protocol. It seeks to provide participants with a balanced understanding of the international response to the challenges of climate change, set out in the previous two sessions. Session 3 also seeks to provide a flavor of the national interest and international politics that have influenced the negotiation of the Convention, and will continue to shape it in the future.
  By the end of the session, participants should have a basic understanding of the following:

a) Historical perspective on the Convention
b) Structure of the Convention, including commitments (differentiation), institutions and procedures
c) Opportunities for finance and support
d) Emergence, elements and commitments of the Kyoto Protocol
e) Flexibility mechanisms
f) Unresolved issues

- **Activities:** Presentation, followed by period of question and answer
- **Total Time:** 45 minutes
- **Materials:** Set of 38OHTs; 3 handouts

International Agreements:

Challenges and Opportunities of the U.N. Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol

Session 3

CCI - Ukraine Workshop Package

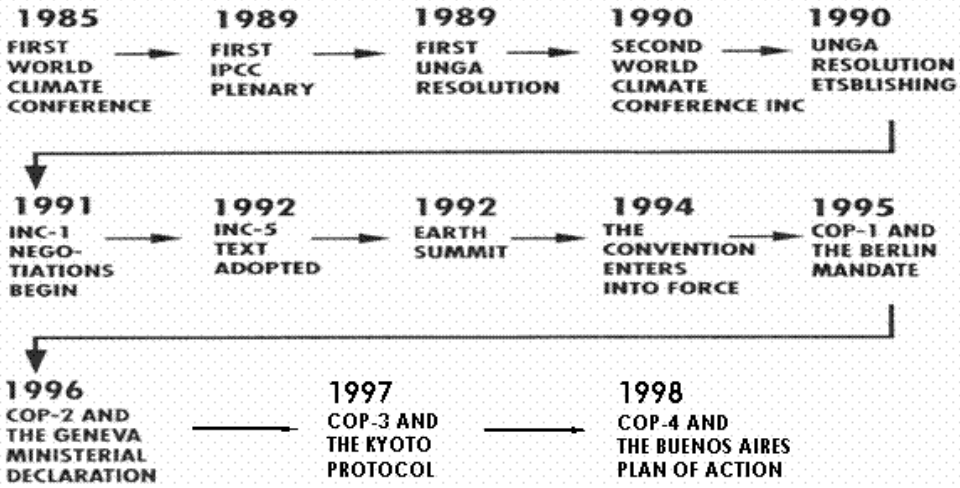
Slide 1

Session Overview

- Historical perspective on the Convention
- Structure of the Convention
  - **Commitments (differentiation)**
  - **Institutions**
  - **Procedures**
- Opportunities for finance and support
- Emergence of the Kyoto Protocol
- Elements and Commitments of the Kyoto Protocol
- Flexibility mechanisms
- Unresolved issues of the Kyoto Protocol

Slide 2

Historical Perspective 1985-98



Slide 3

Recent Developments 1999-2001

Nov. 2000: COP-6 – Parties fail to reach agreement on key Kyoto implementation issues

Jan. 2001: President Bush takes office. Withdraws U.S. support for Kyoto. Continues support of UNFCCC.

July 2001: COP-6 bis – Remaining parties reach agreement on major implementation issues.

Nov. 2001: COP-7 – Remaining parties finalize details on major implementation issues, and many state intent to ratify at Rio+10 Summit in 2002

Slide 4

Ratifications

As of December 2001

- The UNFCCC is in force with almost all of the 188 countries that participate or observe in UNFCCC negotiating sessions have ratified the underlying 1992 treaty.
- About 40 countries have ratified the Kyoto Protocol (primarily small island, Central and South American, and FSU states) and most of the major Annex I countries have stated their intent. However, Kyoto has not come into force yet.

Slide 5

Objective of the Convention

"Stabilisation of the greenhouse gas concentrations in the atmosphere at the level that would prevent dangerous anthropogenic interference with the climate system."

(Article 2 of the Convention)

Slide 6

Objective of the Convention (ctd.)

"… Such a level should be achieved within a time frame sufficient to allow ecosystems to adapt naturally to climate change, to ensure that food production is not threatened and to enable economic development to proceed in a sustainable manner"

(Article 2 of the Convention)

Slide 7

Structure of the Convention

- Commitments
- Institutional Framework
- Procedures

Slide 8

Structure of the Convention

1. Commitments

- National communications
- Mitigation targets
- Financial resources

Slide 9

Differentiation among nations

Article 4.2 (a)

"Developed country Parties and other Parties included in Annex I shall adopt national policies and... measures on the mitigation of climate change, by limiting... emissions ... and protecting and enhancing ... sinks and reservoirs. These policies and measures will **demonstrate that developed countries are taking the lead..."**

"... **taking into account the differences** in Parties' starting points and approaches, economic structures and resource bases, ..., available technologies and other individual circumstances, as well as the need for **equitable and appropriate contributions** ..."

Slide 10

Differentiation among nations (ctd.)

Principles for differentiation of commitments

- Parties' historical emissions of greenhouse gases
- Parties' current emission of greenhouse gases
- Parties' respective capabilities
- Parties' social and economic conditions

Slide 11

Differentiation among Parties

- Annex I countries
  - (OECD + countries with economies in transition)
- Annex II countries
  - (OECD)
- Non-annex I countries
  - (developing countries)
- Least developed countries

Slide 12

Differentiated Commitments

- All Parties will prepare and submit national communications, which should contain:
  - **Inventories of greenhouse gas sources and sinks**
  - **Programmes containing policies & measures to mitigate and adapt to climate change**
- Annex I Parties (developed) should take the lead *by aiming* to stabilise and reduce their emissions of carbon dioxide to 1990 levels by the year 2000 *(few will do so)*.

Slide 13

Differentiated Commitments (ctd.)

- Annex II Parties (OECD) must contribute funding to the financial mechanism so developing countries can implement the Convention.
- Annex II Parties will also promote and finance the transfer of environmentally sound technologies, particularly for developing countries

Slide 14

Differentiated Commitments (ctd.)

- **Timing** of national communications
  - **Developing countries: 3 years after entry into force of the Convention or after availability of financial resources**
  - **Least developed countries: at their own discretion**
- **National communications** of developing country Parties need not be as detailed as those of Annex I.
- **Funding**
  - **Fulfilment of developing country obligations is contingent on availability of financial resources**
  - **Agreed full cost of national communications**
  - **Agreed full incremental cost of mitigation and adaptation measures**

Slide 15

Structure of the Convention

2. Institutional Framework

- Conference of the Parties
- Subsidiary Bodies
- Secretariat
- Financial Mechanism
- Ad Hoc Groups

Slide 16

Institutional Framework

- The Convention established the Conference of the Parties (COP) as the supreme body of the Convention.
- The primary task of the COP is to promote and review the implementation of the Convention and any related legal instruments (e.g., Kyoto Protocol).
- Since the Convention entered into force, March 21, 1994, the Conference of the Parties has convened 7 meetings.

Slide 17

Institutional Framework (ctd.)

- Two Subsidiary bodies have also been established to assist the Conference of the Parties (COP).
- The Subsidiary Body for Scientific and Technological Advice (SBSTA) provides the COP with information and advice on scientific and technological matters.
- The Subsidiary Body for Implementation (SBI) assist the COP in the assessment and review of the implementation of the Convention.
- A permanent secretariat of the Convention was also established at the first session of the COP. The Secretariat is located in Bonn, Germany.

Slide 18

Structure of the Convention

Procedures

- Review of national communications
- Review of adequacy of commitments

Slide 19

Financial Mechanism of the Convention

- The Global Environment Facility (GEF) provides grant and concessional funds to developing countries and those with economies in transition for projects and activities that aim to protect the global environment and achieve the Convention's objectives.
- The GEF supports the full costs of national communications preparation, as well as "agreed incremental costs" of mitigation and adaptation measures and projects. Technical assistance and capacity building activities are also supported by the GEF.
- The GEF has three Implementing Agencies:
  - **United Nations Development Programme (UNDP);**
  - **United Nations Environment Programme (UNEP); and**
  - **The World Bank (IBRD/IFC).**

Slide 20

The Kyoto Protocol

Rationale for the Protocol

– During COP 1 in March 1995, one year after the Convention entered into force, Parties decided existing commitments under the Convention were inadequate

Negotiation of the Kyoto Protocol

– A two-year process conducted by the AGBM

– The Protocol was adopted by the Parties during COP 3 in December 1997 - *a new integral part of the Convention that has yet to enter into force*

Slide 21

Kyoto Protocol Ratification

To enter into force, the Kyoto Protocol requires ratification by no less than 55 Parties, which account for at least 55% of 1990 Annex I emissions of carbon dioxide.

Without the U.S. ratification, all major Annex I countries must ratify for Kyoto to enter into force.

Slide 22

Elements of the Kyoto Protocol

- New GHG emission reduction commitments for industrialised countries
- Cooperative Implementation Mechanisms
- New and additional financial resources to developing countries
- No new commitments for developing countries

Slide 23

Commitments of the Kyoto Protocol

- The overall emission reduction target for Annex 1 Parties as a group is at least 5 percent below 1990 levels to be achieved by the commitment period 2008 to 2012 (an average over the five years).
- The negotiated targets for individual Annex I Parties is included in Annex B of the Protocol.

Slide 24

Selected Quantified Emission Limitations

Industrialized Countries	
• Australia	108
• Canada	94
• EC bubble	92
• (Germany	75)
• (Portugal	140)
• Japan	94
• Norway	101
• New Zealand	100
• [USA]	[93]

As originally negotiated

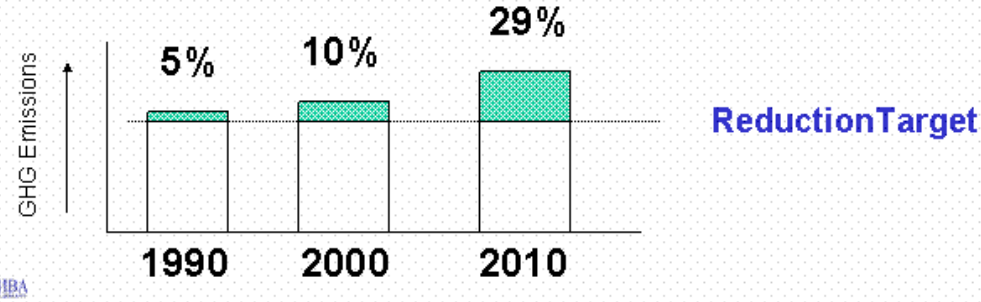
Economies in Transition	
• Bulgaria	92
• Baltics	92
• Croatia	95
• Czech Republic	92
• Hungary	94
• Poland	94
• Romania	92
• Russia	100
• Ukraine	100

Slide 25

Emission Reduction Targets

Actual depth of the cut

- With increasing energy use, reduction targets for 2008-2012 based on 1990 data are greater than they appear - 5% in 1990 vs ~29% in 2010



Slide 26

Commitments of the Kyoto Protocol (ctd.)

- In meeting commitments, an Annex I Party will implement national policies and measures aimed at reducing domestic emissions during the commitment period to a level less than or equal to its 'assigned amount' (AA) under the Protocol
- Additionally, each may supplement domestic reductions with credits for reductions achieved abroad

Slide 27

Commitments of the Kyoto Protocol (ctd.)

The six GHGs controlled by the Kyoto Protocol are:

- carbon dioxide (CO_2)
- methane (CH_4)
- nitrous oxide (N_2O)
- sulphur hexafluoride (SF_6)
- perfluorocarbons (PFCs)
- hydrofluorocarbons (HFCs)

Slide 28

Flexibility Mechanisms

Between Annex I countries

- **Emissions Trading** (Article 17) **between Annex I countries to fulfill their reduction commitments. Any such trading shall be supplemental to domestic actions.**
- **Joint Implementation** (Article 6) - **fulfillment of emissions limitation and reduction commitments jointly among Annex I Parties.**
- **Emissions Bubble** (Article 4) **- fulfillment of emissions limitation and reduction commitments through sharing, between two or more Parties, of aggregated AA's.**

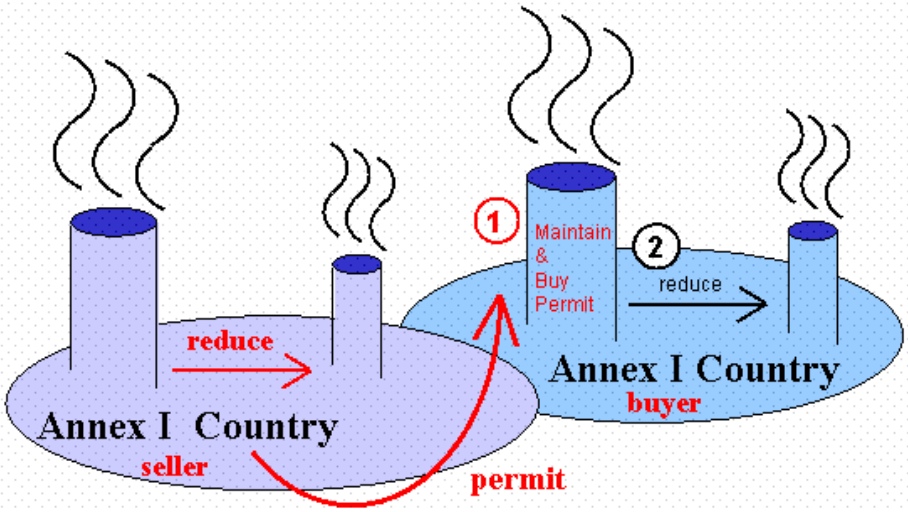
Between Annex I and non-Annex I

- **Clean Development Mechanism** (Article 12) - **to assist Parties not included in Annex I in achieving sustainable development and to assist Annex I countries in achieving compliance with their emission reduction commitments. (Not covered here.)**

Slide 29

The Emissions Trading Transaction

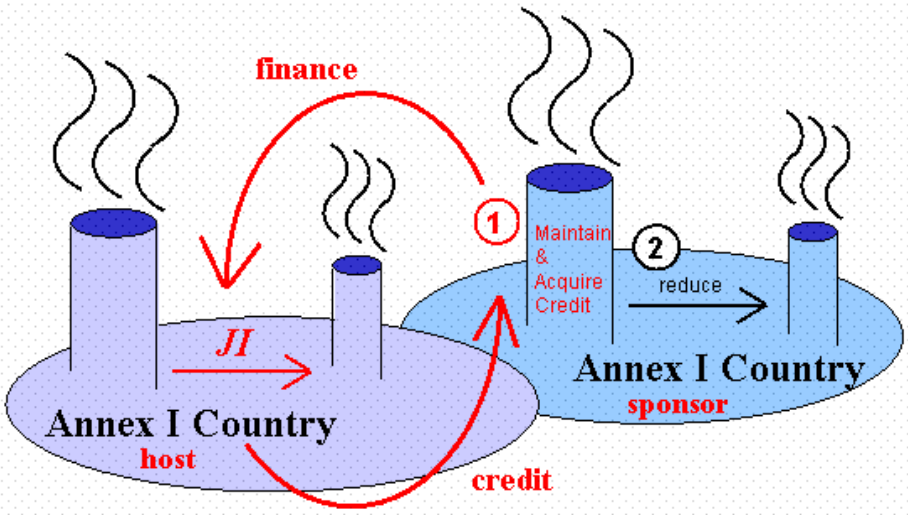
Annex I ↔ Annex I



Slide 30

The JI Transaction

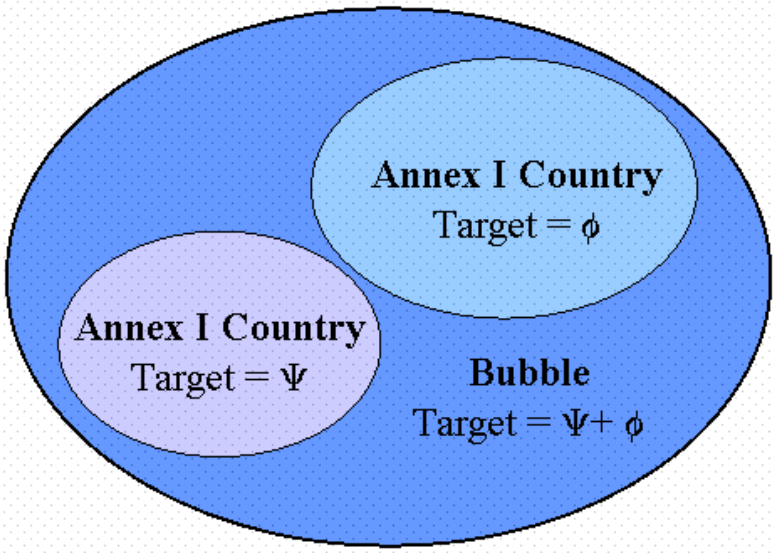
Annex I ↔ Annex I



Slide 31

Emissions Bubble

Annex I ↔ Annex I



Slide 32

Key Outcomes at COP-7

- Compliance regime sets forth consequences for failing to meet targets
- Set criteria for a Party's eligibility to participate in flexibility mechanisms and set some operating rules for JI and CDM
- Allows full fungibility of credits under all flexibility mechanisms, but limits "over-selling" of assigned amounts (AAUs)
- Allows banking of credits, but puts limits on banking of JI and CDM credits
- Requires "commitment period reserve" of 90% assigned amount of allowable reductions to protect against risk of overselling of credits

Slide 33

Key Outcomes re JI at COP-7

- Established a JI Supervisory Committee with rule-writing authority
- Established "second track" for JI for Annex I countries out of compliance or with poor monitoring/reporting. This track will have tougher guidelines similar to CDM.
- JI projects can begin generating ERU's (credits) in 2008, but a project can have started anytime after 2000
- Banking of ERU's limited to 2.5% of a Party's initial assigned amount

Slide 34

Key Outcomes re CDM at COP-7

- Established a CDM Executive Board with rule-writing authority
- CDM projects can begin generating CER's (credits) in 2000, but a project must be registered by 2005
- Allows "unilateral" CDM projects by host
- Banking of CER's limited to 2.5% of a Party's initial assigned amount

Slide 35

Key Outcomes re sinks at COP-7

- Sets rules for use of sinks and creates new "Removal Unit" (RMU) for carbon sequestered through land use/forestry in Annex I countries
- RMUs cannot be banked
- CDM sink projects limited to afforestation and reforestation up to a ceiling of 1% of base year emissions (times 5 years)
- Russia allowed much more credit for forest management activities

Slide 36

Issues for future COP's

- Will the consequences called for in the compliance regime be legally binding?
- Will developing countries undertake voluntary emissions limitation commitments?
- Will financial assistance and technology transfer to developing countries be enhanced?
- Discussion on reduction targets and commitments for the post-2012 period will begin by 2005.

Slide 37

GHG Market Is Emerging

- Despite uncertainties, an "unofficial" GHG market is emerging in anticipation of Kyoto or something like Kyoto being ratified in the future
- Market has companies participating from many countries, e.g., U.S., Canada, Europe, Japan, Australia
- Market has sophistication of trades, forward contracts, futures contracts
- Worldwide players involved, e.g., Price Waterhouse Coopers, Deloitte Touche, NatSource
- Allows early engagement and learning

Slide 38

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 4: Methods of Climate Change Assessment

Overview

- **General Objectives:** Session 4 introduces the participants to the various methodologies used in climate change analysis, providing a thorough overview of each.

  By the end of the session, participants should have a basic understanding of the following:

  g) The vocabulary used in each of the methodologies
  h) The purpose of using each of the methodologies
  i) The primary steps involved in using each of the methodologies
  j) A sense of how the tools can be used in the development of a climate change response

  The module will *not* equip participants to undertake any of the methodologies. It simply provides a basic understanding of what is entailed in undertaking them, and how they can be designed to maximize national benefits, e.g., how they can be used to promote environmental and natural resource management.

- **Activities:** Presentation, followed by period of question and answer
- **Total Time:** 45 minutes
- **Materials:** Set of 17 OHTs; 1 hand-out

Methods of Climate Change Assessment

Module 2, Session 4

CCI - Ukraine Workshop Package

Slide 1

Principal Topics

- National Inventories of Greenhouse Gases
- Vulnerability Assessments
- Adaptation Analysis
- Mitigation Analysis
- Capacity-Building Needs Analysis

Slide 2

Overview

- Methodological tools are used in the development of **national implementation strategies**
- Applying these tools provides basic information needed to formulate **national communications** under the UNFCCC
- The result can also help national governments **formulate projects and programmes** that can be funded under the financial mechanism of the Convention

Slide 3

Key Principles

- Studies should be adapted to fit national circumstances
- Studies should be structures so as to provide feedback and input to national development plans
- Studies should take account of all greenhouse gases, but will typically emphasise carbon dioxide
- Results of the inventory and vulnerability assessments should be used to structure the adaptation and mitigation analyses

Slide 4

Inventories of Greenhouse Gases (GHG)

- Basic methodology developed by IPCC jointly with OECD (IPCC Standards1995)
- Emphasis on GHG emissions from commercial energy sector
- Modified to address emissions from livestock and land-use change
- Most important changes in sinks are due to expansion or contraction of forest area; and,
- Conversion of natural ecosystems or unmanaged lands to agriculture

Slide 5

The National Inventory:

An Assessment of Sources and Sinks of GHGs

- The Convention requires all Parties to report estimates of emissions by sources and uptake by sinks and reservoirs
- This balance sheet provides an estimate of a national contribution to global climate change
- Emissions = Emissions Factor x Activity Data

Slide 6

Three Principal Components of an Emissions Inventory

- Emissions from **fossil fuel use** or non-sustainable use of biomass
- Emissions from **livestock and agriculture**
- Emissions from **land-use change**

Slide 7

Process of uptake by Sinks are not yet well understood

- Uptake by sinks occurs principally in soils and green plants
- Carbon dioxide is taken up by green plants, especially trees
- If the amount of biomass planted is equal to the amount that is burned, then there is no net uptake or release of carbon *(i.e., sustainable use of biomass)*
- If more biomass is harvested than is planted, then carbon is released into the atmosphere *(i.e., unsustainable use of biomass)*

Slide 8

A Vulnerability Assessment

- Pinpoint the risk of rapid climate change for national economies and natural ecosystems
- Identify the economic sectors and geographic regions most at risk
- Identify the components of natural ecosystems that may be negatively affected by rapid climate change

Slide 9

Vulnerability Assessment (ctd.)

- Requires review or evaluation of the effects of climate change, both positive and negative, on populations, economic sectors and ecosystems
- Can be qualitative as well as quantitative in nature
- Is usually based on local experience with past weather events (e.g., severe rain storms, droughts, hot spells, cold snaps, floods, and wind storms) that resemble climate change

Slide 10

Tools for Forecasting Impacts

- **Climate Models** simulate future atmospheric conditions and estimate principal climate variables including temperature, rainfall, runoff, and soil moisture.
- **Impact Models** incorporate climate scenarios to estimate impacts of changes on different sectors (e.g., health, water, agriculture).
- **Analogy**: Based on historical experience that may be local or international, this method incorporates considerations of institutional responses as well as physical events. It can also identify opportunities for long-term economic development and resource management so that adaptation strategies can be developed

Slide 11

Adaptation Analysis

"An Adaptation Analysis highlights the key opportunities, projects, programmes or measures available **to reduce the impacts of those climate changes which cannot be avoided."**

- Asks the question: "what can we do to reduce the economic, physical, and biological damages due to future climate changes ?"
- Includes technological, institutional, behavioural and policy responses

Slide 12

Adaptation Analysis (ctd.)

- May be based on assessments of institutional reform and other behavioural responses to climate change
- Can include both new management techniques, specific educational strategies, and shifts in development plan in light of the risk of rapid climate change
- Can include economic modelling of proposed policies or introduction of new technologies
- Can include physical and engineering analysis of protective measures
- Can include assessments training and communication strategies to increase public awareness

Slide 13

Mitigation Analysis

"A Mitigation Analysis identifies the opportunities to **reduce emissions** of greenhouse gases or reduce the risk of rapid climate changes."

- Asks the question: **"what can we do locally and nationally to reduce the risk of rapid climate changes ?"**
- **Assesses measures** to reduce emissions and enhance local sinks for greenhouse gases
- **Evaluates the economic impact of national measures** and, in particular, **their effects on national development plans**

Slide 14

Mitigation Analysis (ctd.)

- Should look comprehensively at GHG emissions
- Traditionally focused on energy sector measures to:
  - **increase efficiency of energy use**
  - **switch to less carbon-intensive fuels**
  - **alter composition of industrial activity**
- Should also assess opportunities in:
  - **Agriculture**
  - **Forestry**
  - **Industry**
  - **Residential**
  - **Transport sectors**

Slide 15

EIT Countries

- May not reduce their emissions in absolute terms in the near-term
- May reduce the rate of growth in their emissions
- May choose to reduce current and future emissions through Joint Implementation projects with other Annex I countries
- May increase sink capacities by improving management practices in the forestry and agricultural sectors
- May face increased costs (incremental costs) of development resulting from their response to climate change. Such costs may be financed by the Financial Mechanism of the Convention (GEF)

Slide 16

Increasing Capacity:
Building on Existing Strengths

- Parties to the Convention must carefully evaluate their need to build-up existing human and institutional strengths in order to achieve objectives of the Convention
- Institutional reform may be needed to promote the introduction of new technologies
- Education, communication, and training are essential to effective responses

Slide 17

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 5: Financing and Flexibility Mechanisms

Overview

- **General Objectives:** Session 5 introduces the participants to the various methodologies used in climate change analysis, providing a thorough overview of each.

  By the end of the session, participants should have a basic understanding of the following:

  k) The vocabulary used in each of the methodologies
  l) The purpose of using each of the methodologies
  m) The primary steps involved in using each of the methodologies
  n) A sense of how the tools can be used in the development of a climate change response

  The module will *not* equip participants to undertake any of the methodologies. It simply provides a basic understanding of what is entailed in undertaking them, and how they can be designed to maximize national benefits, e.g., how they can be used to promote environmental and natural resource management.

- **Activities:** Presentation, followed by period of question and answer
- **Total Time:** 45 minutes
- **Materials:** Set of 23 OHTs; 1 hand-out

Financing and Flexibility Mechanisms

Module 2, Session 5
CCI - Ukraine Workshop Package

Session Overview

- The objective of the session is to provide a survey of selected international financing mechanisms that are available to support activities that have global environmental climate change benefits.

Selected Financial Mechanisms

- **Global Environment Facility (GEF)**
- **Multilateral Agencies and Development Banks**
- **Bilateral Agencies**
- **Selected Large Private Sector Companies**
- **Flexibility Mechanisms (JI, emissions trading, bubbling)**

Climate Change Project Funding

Funding has been provided for through the Convention and the Kyoto Protocol. Reasons for this include:

- Climate Change is a common concern of humankind
- Developed countries are responsible for the largest share of historical and current global emissions of greenhouse gases
- EIT countries have less capacity than Annex I (developed) countries to implement the Convention
- Developed countries have agreed to provide funding for activities undertaken by developing countries to implement the Convention and its Protocol

Slide 3

Participating in the Kyoto Protocol

(Although the U.S. government has withdrawn its support, it has indicated that it has no objection to other countries ratifying and participating in the Protocol)

The Protocol provides a range of mechanisms

- Domestic policies and measures
- Flexibility mechanisms (Articles 4, 6, 12, 17)
  - Bubbling
  - Emissions Trading (ET)
  - Joint Implementation (JI)
  - Clean Development Mechanism (CDM)

Slide 4

Mechanisms for Implementation:

Domestic policies and measures

- In accordance with national circumstances
  - enhance energy efficiency
  - protect and enhance sinks
  - promote sustainable forms of agriculture
  - research and promote renewable energy
  - eliminate inappropriate fiscal measures
  - encourage reform in transport & energy sectors

Slide 5

Possible Barriers to Mitigation Options:

the need for financial mechanisms

- High initial investment cost
- Insufficient capability in identifying and assessing non-conventional projects
- Perceived alternative technology risk
- Higher transaction costs
- Price distortions
- Regulatory barriers and biases
- Lack of information

Slide 6

Global Environment Facility

- **The Global Environment Facility (GEF) provides grant and concessional funds to developing countries and those with economies in transition for activities that aim to protect the global environment and achieve the Convention's objectives.**
- **GEF supports the full costs of national communications preparation, as well as "agreed incremental costs" of mitigation and adaptation measures and projects. Technical assistance and capacity building activities are also supported by the GEF.**
- **Projects supported by the GEF must be country driven and based on national development priorities. GEF maintains full disclosure of non-confidential information.**
- **GEF advocates consultation and participation of stakeholders.**

Slide 7

GEF Operations

- GEF has three Implementing Agencies:
  - United Nations Development Programme (UNDP);
  - United Nations Environment Programme (UNEP); and
  - The World Bank (IBRD/IFC).
- The GEF Operational Program contains four focal areas:
  - Biological Diversity; **Climate Change**; International Waters; and Ozone Depletion.
- The Climate Change Focal Area includes:
  - Three operational programs
  - Enabling Activities
  - Short-Term Response Measures

Slide 8

Steps in GEF Project Development

- Scope-out impeded win-win activities that have global environmental benefits
- Identify specific barriers that are currently impeding the option
- Perform incremental cost analysis for implementation of the option
- Propose GEF intervention
- Demonstrate sustainability

Slide 9

Mechanisms for Implementation: Flexibility Mechanisms

- Why so much interest in these mechanisms?
  - Address emission reduction cost concerns
  - Provide for flexibility in achieving targets
  - Provide opportunities for access to the best current and future energy efficient technologies
  - Provide opportunities for more energy efficient markets
  - Involve non-state entity participation

Slide 10

Mechanisms for Implementation

Joint Implementation (JI)

- Project-based mechanism whereby a developed country can receive credits (ERU's) when helping to finance projects in another developed country or EIT country (art. 6)
- Conditions are same as emissions trading though Protocol explicitly permits non-state entity participation
- Activities Implemented Jointly (AIJ) provided a pilot phase for such projects

Slide 11

Mechanisms for Implementation

Activities Implemented Jointly (AIJ)

AIJ under the Pilot Phase

- AIJ pilot phase was established at the first meeting of the COP in Berlin in 1995. (Decision 5/CP.1)
- Emission reductions realized during the pilot phase can not be used to meet reduction commitments under the Protocol.
- The primary purpose of the pilot phase is for all Parties to "learn by doing" and thus gain experience with AIJ.
- As of early 1999, approximately 123 AIJ projects are under implementation or being planned (JIQ, 1999) of which 40 are in Non-Annex I countries.
- At the COP 5, Parties may request a comprehensive review of the AIJ under the pilot phase.

Slide 12

U.S. Initiative on Joint Implementation

- USIJI pilot program was launched in 1993 as part of the US Climate Change Action Plan.

Rational for Joint Implementation

- Transfer of technologies via partnerships
- Efficient reduction of global GHG emissions
- Contribute to sustainable development
- Increase private sector investment in developing countries
- Expand new markets for innovative "green" technologies
- Enhance local environmental and human health benefits

Slide 13

U.S. Initiative on Joint Implementation

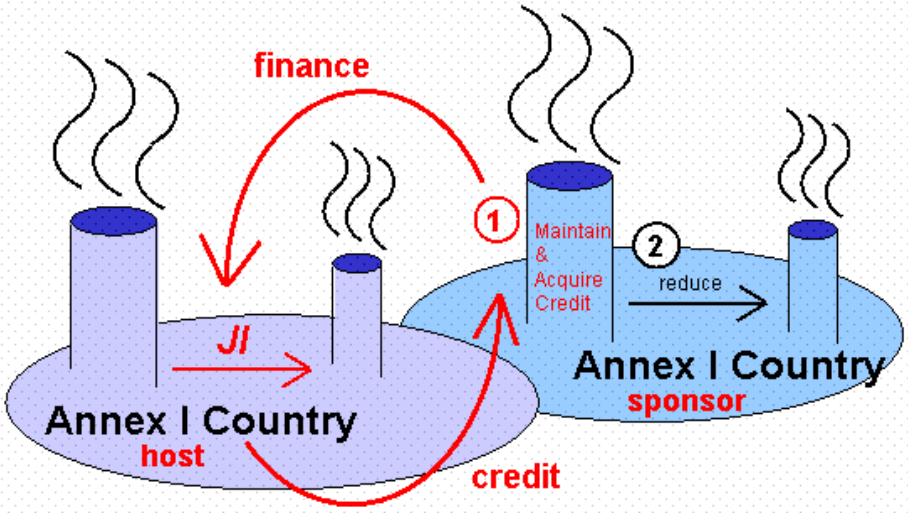
Selected USIJI Accepted Projects

- Poland - Coal Bed Methane Recovery (Aquatech Services, Inc. of Fair Oaks, CA)
- Philippines - Energy Efficient Street Lighting (International Institute for Energy Conservation)
- Czech Republic - Fuel Switching and Cogeneration (US electric utilities and Center for Clean Air Policy)
- Honduras - Bio-Gen Biomass Power Generation Project

Slide 14

The JI Transaction

Annex I ↔ Annex I



Slide 15

Mechanisms for Implementation

Joint Implementation (JI) ctd.

- Ideal JI project
  - Domestic regulation in investor country A leads corporation X to invest in technology-transfer project which reduces emissions in host country B
  - Corporation X saves $, Country B receives investment and technology, resulted in decreased emissions - a "win-win" scenario
- Possible only if
  - marginal cost to reduce x unit of GHG in investor Country A is significantly higher than in host Country B
  - mechanisms in Country B are in place to measure, monitor and certify GHG reductions resulting from investment by corporation X in Country A
  - mechanisms, methodologies and institutions are in place to oversee projects and credits

Slide 16

Mechanisms for Implementation

Joint Implementation (JI) ctd.

- **Outstanding issues** (building confidence)
  - allowable emissions must be allocated amongst participants
  - requires definition of appropriate "part" of country's emission reduction commitment
  - relies on outstanding issues related to certification, verification and compliance

Slide 17

Mechanisms for Implementation

Emissions Trading and "Bubbles"

"The Parties included in Annex B may participate in emissions trading for the purposes of fulfilling their commitments…" [Kyoto Protocol, Art.17]

> **Emissions trading:** Parties may purchase and sell emissions allowances, to help them meet their targets.

"Any Parties included in Annex 1 that have reached an agreement to fulfil their commitments under Article 3 jointly, shall be deemed to have met those commitments provided that their combined emissions do not exceed their assigned amounts…" [Kyoto Protocol, Art.4]

> **Bubbles**: Parties may group together to jointly satisfy their targets, (e.g. EU)

Slide 18

Mechanisms for Implementation

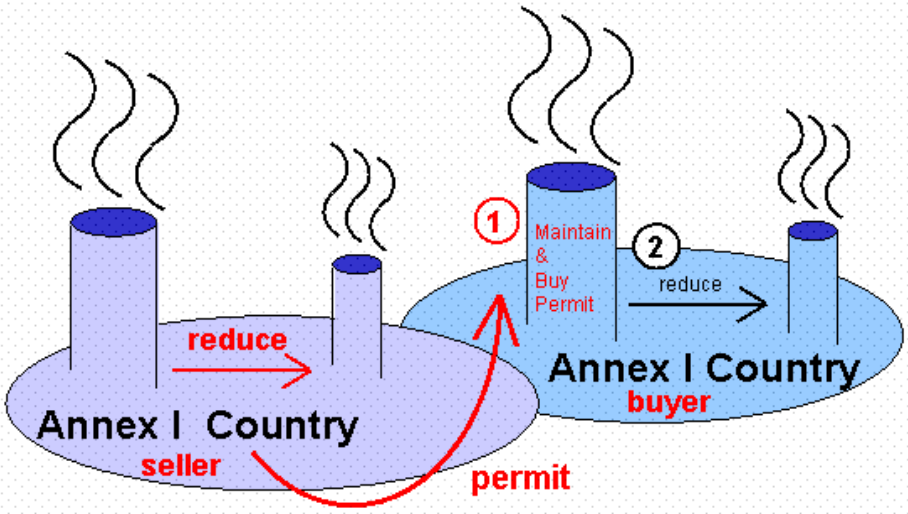
Emissions Trading

- The traded quantity is a part of the assigned amount of the selling Party: measured in tons CO_2-equivalent
- All six gases treated interchangeably. Allowances valid for: CO_2, CH_4, N_2O, HFCs, PFCs, SF_6
- Trades might be negotiated even before first budget periods.
- Trades might involve national governments and any other government-endorsed legal entity (for example, if national trading system is in place).

Slide 19

The Emissions Trading Transaction

Annex I ↔ Annex I



Slide 20

Mechanisms for Implementation

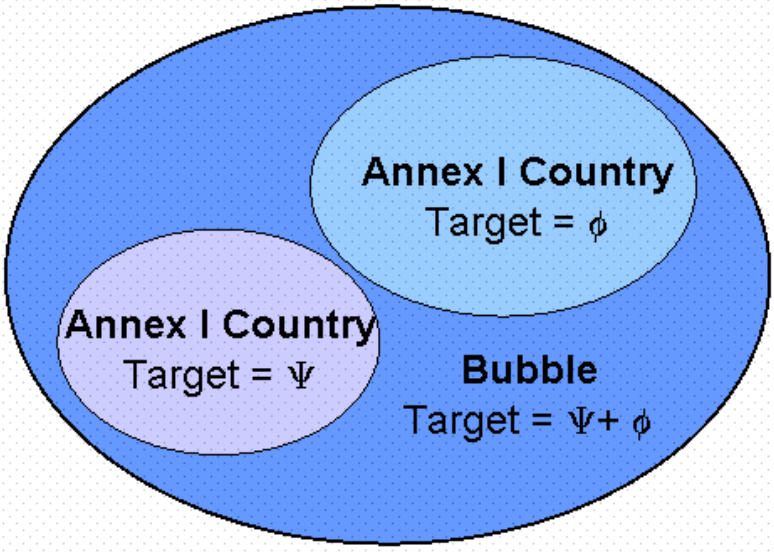
Joint targets or 'Bubbling'

- Agreement between specified group of countries to meet targets jointly as aggregate
- The EU will pursue this approach

Slide 21

Emissions Bubble

Annex I ↔ Annex I



Slide 22

Mechanisms for Implementation

Summary

Characteristics	Joint Targets (Bubbling)	Emissions Trading (ET)	Joint Implemntation (JI)	Clean Developmnt Mechanism (CDM)
Provision in Protocol	Article 4	Article 17	Article 6	Article 12
Investors (Transferees)	Annex I	Annex I	Annex I	Annex I
Hosts (Transferors)	Annex I	Annex I	Annex I	Non-Annex I
Nature of Mechanism	Inventory-based	Inventory-based	Project-based	Project-based
Compliance Conditionality	Notification to Secretariat	Verification rules pending	Yes, Articles 5, 7, 8	Pending (?)

Slide 23

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 6: Inventory of GHG Emissions

Overview

- **General Objectives:** Session 6 introduces the participants to the various methodologies used in development of GHG emissions inventory. In particular IPCC approaches are presented.

  By the end of the session, participants should have a basic understanding of the following:

  o) Top-down and bottom-up approaches;

  p) The different sources of GHG emissions.

- **Activities:** Presentation, followed by period of question and answer
- **Total Time:** 60 minutes
- **Materials:** Set of 35 OHTs

Suggested Readings

IPCC guidelines on national inventory preparation. Joint IPCC/OECD program . Volume 1: Reporting instructions for GHG inventory. Volume 2: Workbook of the GHG inventory .

IPCC (Intergovernmental Panel on Climate Change) (1997), *IPCC Guidelines for National Greenhouse Gas Inventories,* 3 volumes: Vol. 1, Reporting Instructions; Vol. 2, Workbook; Vol. 3, Reference Manual. Intergovernmental Panel on Climate Change, United Nations Environment Programme, Organization for Economic Co-Operation and Development, International Energy Agency. Paris, France.

Carbon Dioxide Information Analysis Center. Website. http://cdiac.esd.ornl.gov

Marland, G., and Rotty, R. (1984) Carbon dioxide emissions from fossil fuels: a procedure for estimation and results for 1950-1982. Tellus, 36b, 232-261.

United Nations Framework Convention on Climate Change.Website.http://www.unfccc.de/

Inventory of GHG Emissions

Session 6

Module 2: Economics of Climate Change

Emissions sources from "Energy" sector

I. FUEL COMBUSTOIN ACTIVITIES

- Heat and electric energy production
- industry
- transportation: auto, air, water, railroad, pipeline
- commercial/institutional
- residential
- agriculture/forestry
- other sectors
- biomass burned for energy production

II. FUGITIVE EMISSIONS

- coal mining
- oil and gas sector

Slide 2

Major greenhouse gases in the "energy" sector

Direct GHG:

- carbon dioxide - CO_2,
- methane - CH_4,
- nitrous oxide - N_2O

Indirect GHG:

- oxides of nitrogen (NO_x)
- non-methane volatile organic compounds (NMVOC)
- carbon monoxide (CO)

Slide 3

Carbon Dioxide Emissions

- When fuels are burned, most carbon in the fuel is emitted as CO 2 immediately during the combustion process.
- Some carbon is released as CO, CH 4 or non-methane hydrocarbons which oxidise to CO 2 in the atmosphere within a certain period of time.
- Some of the carbon remains unburned or partially oxidised as soot or ash (due to inefficiencies in the combustion process).
- Different fuel types have different carbon content per unit of useful energy:
  - Coal has the most carbon per unit of useful energy
  - Oil has about 80% the carbon of coal
  - Natural Gas has about 55% the carbon of coal

Slide 4

General equation for calculating CO_2 emissions from fossil fuel combustion

Actual CO_2 released across all fossil fuel types is calculated according to the following formula:

$$CO_2 = [(C_p - C_s) \times C_o] \times 44/12$$

where:

C_p = potential carbon releases

C_s = sequestered (stored) carbon

C_o = % of oxidized carbon

44/12 – molecular to atomic ratio of carbon in carbon dioxide

Slide 5

Two approaches to calculate CO_2 emissions

1. The IPCC Reference Approach or "Detailed Fuels Approach" or "Top-Down" Method.

Requires Information Only on the Quantities of Fuels Produced Indigenously, and Those Flowing Into and Out of the Country through Imports or Exports.

2. "Detailed Technology-Based Calculation" or "Bottom-Up" Method.

Requires a Substantial Amount of Information about National Energy Consumption Patterns in Each Sector of a Nation's Economy.

Slide 6

Types of Fuel

Liquid fossil fuel

- Primary: *crude oil, gas condensate*
- Secondary: *petroleum, kerosene, diesel fuel, mazut, liquefied gas, bitumen, lubricants, petroleum coke, other liquefied oil products*

Solid fossil fuel

- Primary: *anthracite, coking coal, bituminous, lignite, peat*
- Secondary: *coke, briquettes*

Gaseous fossil fuel

- Primary: *natural gas*

Slide 7

IPCC Reference Approach

Carbon accounting is based mainly on the total supply of primary fuels and the net quantities of secondary fuels brought into a country.

Step 1: Estimating consumption of fuels by fuel type (AP):

$$(AP) = P + I - E - IB - SC,$$

where P = production
I = imports
E = exports
IB = international bunkers
SC = stock change

(A Stock Build is Positive; A Stock Drawn is Negative)

Fuel consumption may be measured in tons of oil or coal equivalent, terra calories, terra joules, or other standard units.

Slide 8

IPCC Reference Approach (cont.)

Step 2: Convert the consumption data in original units into a common energy unit Conversion factors are based on the heat content of each fuel

- For example:
  - 10^6 tons of oil equivalent = 4.1868 * 10^4 TJ
  - 1 tera calorie = 4.1868 TJ
  - 1 TJ = 10^{12} J
- Other metric energy units:
  - 1 exa joule (ЭДж) = 10^6 TJ
  - 1 peta joule (ПДж) = 10^3 TJ
  - 1 giga joule (ГДж) = 10^{-3} TJ
  - 1 mega joule (МДж) = 10^{-6} TJ
  - 1 kilo joule = (КДж) = 10^{-9} TJ

Slide 9

IPCC Reference Approach (cont.)

Step 3: Selecting carbon emission factors for each fuel product type and estimating the total carbon content of the fuels

Total carbon content (C_p)

C Gg = Σ apparent energy consumption (by fuel type in TJ) * carbon emission factor (by fuel type in tons of C per TJ) * 10^3

Slide 10

IPCC Reference Approach (cont.)

Step 4:Estimating the Amount of Carbon Stored in Products for Long Periods of Time (example: plastics, nylon)

General formula is :

Total Carbon Stored (Gg C) = Non-Energy Use (10^3 t) x Conversion Factor (TJ/10^3 t) x Emission Factor (t C/TJ) x Fraction Carbon Stored x 10^3

Where Non-Energy uses of combustible include:Naphtha, lubricants, Bitumen, Coal Oils/Tars, Gas as Feedstock, Gas/Diesel Oil as Feedstock, LPG as Feedstock

Slide 11

IPCC Reference Approach (cont.)

Step 5: Accounting for Carbon Not Oxidised During Combustion

Carbon oxidized during combustion = $(C_p - C_s)^* C_o$

The Assumption for the Fraction of Carbon Oxidised is:

- Coal = 91- 98 %
- Oil and Oil Products = 99 %
- Gas = 99.5 %
- Peat for Power Generation = 99 %

Apply to Each Fuel Type and Sum Up for Total Carbon Emissions

Slide 12

IPCC Reference Approach (cont.)

Step 6: Converting Emissions as Carbon to Full Molecular Weight of CO 2

Total Carbon Dioxide Emitted from Fuel Combustion = Total Carbon Emissions (from Step 5) x the Molecular Weight Ratio of CO 2 to C (44/12)

- International bunkers Emissions are Calculated Separately with the use of the same Calculation Methodology and Excluded from National Totals

Slide 13

Detailed technology-based approach

- GHG emissions are assessed according to economic sector and/or type of technology used.
- Approach is conceptually similar to the Reference Approach.
- Countries should also apply the Reference Approach and attempt to compare the results.
- Method is applied for calculating CO2 and other GHG emissions from fuel combustion
- Countries are to determine the level of detail they want to apply to calculations

Slide 14

Detailed technology-based approach (cont.)

Emissions are calculated at least for the following sectors:

- Energy transformation
  - heat and electric energy
  - oil refineries
- Transportation
- Industry
- Agriculture
- Residential
- Commercial / Institutional

Slide 15

Detailed technology-based approach (cont.)

Steps in calculation

- **Step 1**: Estimate Fuel Consumption by Sector and Technology Type
- **Step 2**: Convert to a Common Energy Unit
- **Step 3**: Multiply by Appropriate Carbon Emission Factors to Compute Potential Emissions
- **Step 4**: Estimate the Amount of Carbon Stored in Products for Long Period of Time
- **Step 5**: Adjust for Unoxidised Carbon
- **Step 6**: Convert Emissions as Carbon to Full Molecular Weight of CO 2

Slide 16

Detailed technology-based approach (cont.)

Carbon Emissions = Fuel Consumption (actual rather than apparent) Expressed in Energy Units (TJ) x Carbon Emission Factor - Carbon Stored x Fraction Oxidised

Calculation of other GHG emissions from stationary sources:

$$\text{Emissions} = \Sigma(EF_{abc} \times \text{Activity}_{abc}),$$

where: ***EF*** = emission factor (kg/TJ),
Activity - energy input (TJ),
a - fuel type,
b - sector activity,
c - technology type.

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Detailed technology-based approach (cont.)

Non-CO_2 emissions from stationary sources include:

- 2 Direct GHGs: CH 4 and N 2 O
- 3 Indirect GHGs: NO x , CO and NMVOCs

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Detailed technology-based approach: major steps to estimate non-CO_2 emissions)

1. Determine Source and Form of Energy Activity Data

- best available sub-national, national and/or international data

2. Develop Emission Factor Data

- default values in Reference Manual are in need of improvement
- based on fuel type, technology, operating conditions, maintenance and vintage of technology

3. Identify the Technology Splits for Energy Data

- according to main technology type and the extent of pollution control

Slide 19

GHG emissions from mobile sources

- CO_2 emissions from mobile sources are calculated together with the other economy sectors
- Non-Co_2 emissions are due to incomplete combustion and other GHGs post-combustion controls
- Estimation of mobile sources emissions requires consideration of many parameters, including fuel type, vehicle type, pollution control equipment type.

Slide 20

GHG emissions from mobile sources: *parameters to determine emission factors*

- Transport class: *road, non-road*
- Fuel consumed: *gasoline, diesel, natural gas, liquefied gas, methol/ethanol*
- Pollution control: *Advanced 3-way and early 3-way,oxidation catalyst, moderate control, no control*
- Vehicle type: *cars, light vehicles, heavy-duty vehicles, motorcycles, ships/boats, locomotives, farm equipment, aircraft, etc.*

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GHG emissions from mobile sources (cont.)

- **Basic calculation:**

$$\text{Emissions} = (EF_{abc} * FC_{abc}),$$

where,

EF - emission factor

FC - amount of energy consumed or distance traveled

a - fuel type (e.g. diesel, gas)

b - vehicle type (e.g. cars, HDV)

c - Emission control

Slide 22

GHG emissions from mobile sources: *steps to follow*

Step 1a: Determine amount of energy consumed (by fuel type and transport modes)

Step 1b: If distance traveled is activity measure, determine average distance traveled for each vehicle and fuel type

Step 2: Multiply amount of energy consumed, or distance traveled by each category of vehicle, by corresponding emission factor.

Step 3: Sum across all fuel categories and technology types

Slide 23

GHG emissions from mobile sources: *challenges and limitations*

- Emission Factors Rely Heavily on Experience Measurements in Industrialised Countries
- Data on Technology Splits and Level of Pollution Control is Not Readily Available
- Much of the Relevant Data May Exist, but is Not Easily Obtained

Slide 24

GHG emissions from burning biomass fuel

- Biomass fuel (e.g. wood, charcoal, biogas) are used in variety applications, including residential, commercial and industrial
- Biomass combustion results in emission of all greenhouse gases
- Net CO_2 emission at "renewable" use is treated as zero
- CO_2 emission for land-use change are accounted in "Land-Use Change and Forestry" section

Slide 25

GHG emissions from burning biomass fuel (cont.)

Two steps of calculation:

Step 1

- carbon released from biomass = total biomass consumed * fraction oxidized * carbon fraction
- carbon released from charcoal production = (fuel wood used in charcoal production * fraction of fuel wood) - (charcoal produced * carbon fraction of charcoal)

Step 2

- Non-CO_2 emissions = carbon released * emission ratio * molecular weight ratio (R)
- R = CH_4 :16/12, N_2O : 44/28, NO_x : 46/14, CO : 28/12

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Fugitive emissions (leaks) from coal mining and handling activities

- Fugitive emissions of methane (CH_4) occur from production, processing, handling and utilization of coal
  - emission level depends on coal rank and depth, gas content, mining method, etc.
- Other fugitive emissions include CO_2 from burning coal mines and waste piles and from SO_2 scrubbing

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Fugitive emissions from coal production

Calculation levels:

Level 1: use of average common emission factors

Level 2: use of average emission factors for a country or a mining area

Level 3: individual calculation for mines or mine sections

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Fugitive emissions from coal handling activities

- Major sources include underground mining, surface mining, processing, transportation and handling
- Methane emissions (Gg CH_4) = emission factor ($м^3$ CH_4 / ton) * coal production (tons) * conversion factor (Gg / 10^6 $м^3$) - methane captured (Gg)
- Emission factors reduce by activities: underground mining, surface mining, post-mining activities
- Conversion factor under 20°C and 1 atmosphere is 0.67 Gg / 10^6 $м^3$ CH_4)

Slide 29

CO 2 Emissions from Burning Coal Deposits and Waste Piles

The General Formula for Calculating is:

Emissions from Coal Burning (Gg C) = Quantity of Coal Burned (103t) x Emission Factor

Where: Emission Factor is:

Percentage of Carbon in Coal x Percentage of Carbon Oxidised; (and the default value is 50%)

CH_4, N_2O, CO and NO_x are among other GHG Emissions from Combustion of Coal Waste

Care should be taken to avoid double counting (in this section and "fuel combustion" section).

Slide 30

Methane emissions from oil and natural gas production, processing, transportation and handling

- Emissions from oil and gas sector include:
  - from regular system operation
  - from burning in torches and fugitive emissions
  - from repair and maintenance
  - emergency emissions
- Major activities resulting in emissions include:
  - oil and gas recovery
  - oil transportation
  - natural gas storage and processing
  - natural gas transportation and distribution

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Methane emissions from oil and natural gas production, processing, transportation and handling

Calculation levels:

Level 1: use of average emission factors and aggregated statistical data on production, transportation and consumption

Level 2: oil and gas balance and emission factor calculation

Level 3: Use of local emission factors and calculation by segments of oil and gas industry

Slide 32

Methane emissions from oil and natural gas production, processing and transportation

- Level 1 calculation methodology
  - Data required: oil and gas production, oil refinery and transportation, gas processing, transportation and distribution in peta joules, PJ = 10^{15} J (A)
  - emission factor (EF, kg CH_4/PJ) (F)
  - Emissions = A * F
  - Emissions are summed across categories
- Emission factors are calculated for 5 regions: USA and Canada, former USSR countries and Eastern Europe, Western Europe, oil producing countries, the rest of the world

Slide 33

"Good practice" for GHG inventory

- According to the recent IPCC recommendations, a good GHG inventory:
  - uses detailed methods and data
  - includes emissions calculations up to the recent years
  - provides an estimate of calculation inaccuracy
  - provides detailed description of data and methods used
  - is based on detailed calculation quality verification

Slide 34

GHG emissions calculation for Ukraine, 1990

(example and practical tasks)

- The aim of the practical tasks is to estimate emissions from the "energy" section with the help of IPCC worksheets (Guidelines, volume 2)

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MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 7: Inventory of GHG Emissions in the Coal Sector in Ukraine

Overview

In compliance with the preliminary agenda we suggest the inclusion of the following theme:

- Ukraine's GHG Inventory in coal sector

  Information is updated depending on the development of new national climate change programs and strategies.

As an example we give presentation based on the First National Communication on issues of climate change.

It is recommended to invite authors of programs and strategies for presentation of their developments.

Инвентаризация выбросов парниковых газов в угольной промышленности Украины

Inventory of GHG emissions in the coal sector of Ukraine

Session 7

Module 2: Economics of Climate Change

Slide 1

Программа US EPA по разработке метана угольных месторождений в Украине:

US EPA CBM Outreach Program in Ukraine:

Исполнитель: Партнеры по Экономической Реформе

Implementor (grantee): Partners in Economic Reform, Inc.

Украинские партнеры:

- Министерство экологии и природных ресурсов
- Центр альтернативных видов топлива

Ukrainian Partners:

- Ministry of ecology and natural resources
- Alternative Fuels Center

Slide 2

Программа US EPA по разработке метана угольных месторождений в Украине:

US EPA CBM Outreach Program in Ukraine:

Главная цель программы:

Main objective:

Способствовать освоению ресурсов метана угольных месторождений в Украине

Facilitate Ukrainian coal bed methane resources exploration through:

- экологическая оценка влияния выбросов метана из угольных шахт
- *environmental assessment of coal mine methane emissions*
- информационная поддержка инвестиционных проектов
- *information support of CBM/CMM projects*

Slide 3

Программа US EPA по разработке метана угольных месторождений в Украине:

US EPA CBM Outreach Program in Ukraine:

Работы в рамках программы: **Program Activities:**

- Инвентаризация эмиссий шахтного метана в Украине
- *CMM emissions inventory for Ukraine*
- Публикация справочника о газовых шахтах Украины, наиболее привлекательных для инвестиционных метановых проектов
- *Development of the handbook about Ukrainian mines most attractive for CMM projects development*
- Подготовка бизнес-планов для проектов по разработке и утилизации метана на шахтах Донбасса
- *Development of business plans for two mines*
- Распространение этих документов для привлечения потенциальных иностранных инвесторов к реализации метановых проектов
- *Dissemination of these materials among potential investors*

Slide 4

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

- US EPA выделило грант для проведения инвентаризации метана на уровне отдельных шахт по всей Украине за период 1990 - 1999 г. Это первая попытка провести инвентаризацию эмиссий на уровне отдельных предприятий в целом по стране.

US EPA gave a grant to develop a mine-specific CMM emissions inventory of Ukraine for 1990-1999. This is the first attempt to develop a site-specific GHG inventory in Ukraine.

- В предыдущих кадастрах парниковых газов эмиссии шахтного метана были подсчитаны на основании методологии, рекомендованной РКИК. Общее производство угля умножалось на коэффициенты эмиссии для соответствующих регионов.

Previous Ukrainian inventories accounted for CMM emissions based on calculations under the IPCC guidelines. I.e. the total emissions were obtained multiplying the coal production by basin-specific emissions factors

- В настоящем кадастре более 85% данных - статистические данные, предоставленные шахтами.

The current inventory consists of more than 85% actual measurement data

Slide 5

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

Источники данных для кадастра эмиссий шахтного метана:

Data sources for CMM emissions inventory

- Департамент Угольной промышленности Министерства топлива и энергетики Украины; *Department of coal industry of the Ministry of fuel and energy of Ukraine*
- Министерство экологии природных ресурсов Украины; *Ministry of ecology and natural resources of Ukraine*
- Государственный Комитет по охране труда Украины; *State Committee for Labor Safety of Ukraine*
- Макеевский НИИ по безопасности работ в горной промышленности (МакНИИ); *Makeyevka mine safety institute*
- Центр альтернативных видов топлива; *Alternative Fuels Center*
- Угольные Государственные холдинговые компании; *Coal Associations*
- отдельные шахты; *Individual mines*
- данные украинских экспертов *Ukrainian experts' data*

Slide 6

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

В кадастре эмиссий шахтного метана (1990 - 1999) ассмотрены следующие категории эмиссий в Донецком и Львовско-Волынском угольных бассейнах Украины:

The following categories of emission sources were considered for Donetsk and Lviv-Volyn coal basins of Ukraine:

- эмиссии метана при подземной добыче угля;

emissions from underground coal production

- эмиссии метана при добыче угля открытым способом;

emissions from surface coal production

- эмиссии метана при последующей деятельности;

emissions from postmining activity

- объемы извлеченного и использованного метана.

recovered and utilized methane

Slide 7

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

Методология учета эмиссий шахтного метана:

CMM emissions inventory methodology:

Общая эмиссия (годовая)=

эмиссия метана при подземной добыче угля

+ эмиссия метана при добыче угля открытым способом

+ эмиссия метана при последующей деятельности

- объемы извлеченного и использованного метана.

Total emission =

emissions from underground mining

+emissions from surface mining

+emissions from postmining activity

- recovered and utilized methane

* В кадастре учтены только эмисии метана при добыче угля на действующих угольных шахтах Украины

Only emissions from active mines were considered

Slide 8

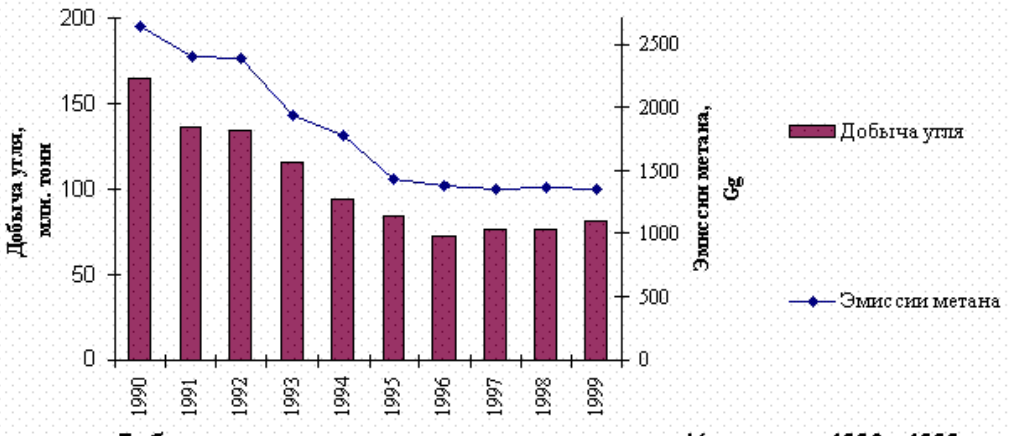
Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

Методология учета эмиссий шахтного метана:

- Эмиссия метана при подземной добыче угля: *Underground coal production:*
  статистические данные по эмиссии из систем вентиляции и дегазации, полученные от шахт;
  actual measurements from degasification and ventilation systems;
- Эмиссия метана при добыче угля открытым способом: *Surface mining:*
  объем добычи угля х коэффициент эмиссий (по бассейнам)
  coal production X basin-specific emissions factor
- Эмиссия метана при последующей деятельности (транспортировка, обогащение, использование угля): *Postmining activity:*
  объем добычи угля х коэффициент эмиссий (по бассейнам)
  coal production X basin-specific emissions factor
- Объемы извлеченного и использованного метана:
  статистические данные, полученные от шахт
  actual mine-specific data from the mines

Slide 9

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):



Добыча угля и эмиссии шахтного метана в Украине за 1990 - 1999.
Coal production and CMM emissions in Ukraine in 1990-1999.

Slide 10

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

За период 1990 - 1999 г. в Украине:

During 1990-1999 in Ukraine

- добыча угля сократилась с 165 млн.тонн до 80 млн. тонн

coal production reduced from 165 million tonnes to 80 Mt

- количество шахт сократилось с 284 до 244

number of mines reduced from 284 to 244

- эмиссии метана сократились с 2,637.92 Gg до 1,345.51 Gg

methane emissions reduced from 2,637.92 Gg to 1,345.51 Gg

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Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999
Высвобождено (подземная добыча угля) Liberated underground	2,518.04	2,321.96	2,209.90	1,825.93	1,706.43	1,383.74	1,312.60	1,289.41	1,316.86	1,290.89
Утилизировано (подземная добыча угля) Utilized	98.46	93.84	Н/Д	47.19	64.54	60.55	32.69	38.59	56.63	53.68
Общая эмиссия (подземная добыча угля) Total emitted underground	2,419.58	2,228.12	2,209.90	1,778.74	1,641.89	1,323.19	1,279.91	1,250.82	1,260.23	1,237.21
Эмиссия при добыче открытым способом Emitted, surface	8.70	6.74	5.42	3.89	2.50	2.15	1.49	1.34	1.31	1.11
Эмиссия при последующей деятельности (для подземной добычи) Postmining underground	208.40	172.12	171.27	149.55	122.99	108.96	93.90	99.79	100.19	107.03
Эмиссия при последующей деятельности (для открытой добычи) Emission Surface	1.24	0.96	0.77	0.56	0.36	0.31	0.21	0.19	0.19	0.16
Общая эмиссия TOTAL EMISSIONS	**2,637.92**	**2,407.94**	**2,387.36**	**1,932.74**	**1,767.74**	**1,434.61**	**1,375.51**	**1,352.14**	**1,361.92**	**1,345.51**

Результаты инвентаризации эмиссии шахтного метана в Украине (Gg) за период 1990 – 1999. Ukrainian CMM emissions inventory results (1990-1999)

Slide 12

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999): Ukrainian Inventory of coal mine methane emissions (1990-1999):

Характерные показатели и результаты инвентаризации:

Some indicators and results of the inventory:

- В Украине 98% эмиссий шахтного метана приходится на подземную добычу угля;

98% of CMM emissions in Ukraine come from underground mining

- Основная часть метана выбрасывается в атмосферу:

Most of methane is emitted to the atmosphere

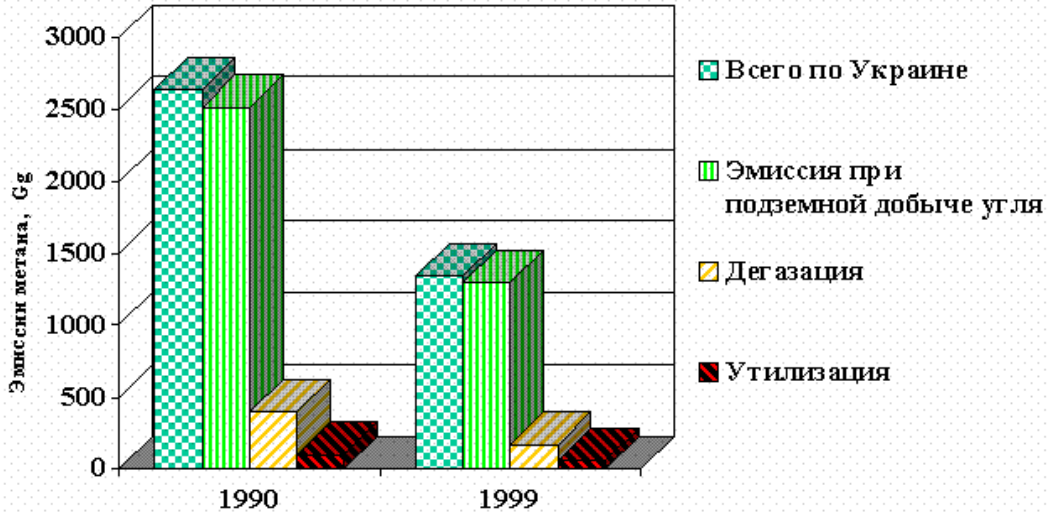
  - высвобождено в 1999 г. при подземной добыче 1,290.89 Gg
  - *total liberated methane underground 1,290.89 Gg in 1990*
  - каптировано в 1999 г. 174.31 Gg (13% от высвобожденного)
  - *captured 13% of total liberated methane in 1999*
  - утилизировано в 1999 г. 53.68 Gg (30% от каптированного)
  - *utilized 30% of captured methane in 1999*

- Данные инвентаризации отличаются от ранее полученных расчетным путем и представленных в предыдущих Национальных сообщениях на 5 - 8%

Current inventory results differ from previous National communications by 5-8%

Slide 13

Инвентаризация эмиссий шахтного метана в Украине (1990 - 1999):



Slide 14

Утилизация шахтного метана в Украине
Methane utilization in Ukraine

В настоящее время реально шахтный метан используется следующим образом:

Currently there are following examples of CMM utilization in Ukraine:

- Шахтные котельные - перевод с угля на газ:

Mine boilers - switch from coal to gas

  - 8 шахт Донбасса используют метан для собственных нужд
  - *8 Donbass mines use CMM for self needs*

- Моторное топливо

Motor fuel

  - 3 автозаправочные станции (шахта им.Засядько, НПП Донугледегазация»)
  - *3 car gas-filling stations*

Slide 15

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 8: Introduction to Climate Change Mitigation Analysis

Overview

General Objectives: By the end of the session, participants should have a basic understanding of the history, purpose and design of mitigation assessment. Specifically:

- The role of mitigation analysis within the UNFCCC
- The basic concepts behind climate change mitigation
- The primary steps and technical methods involved in carrying out a mitigation analysis
- Ukraine's specific circumstances, considerations and option, with regard to mitigation

Activities: An overhead slide presentation, followed by period of questions and answers

Total Time: 30 to 45 minutes

Materials: Set of 20 OHTs

Introduction to Climate Change Mitigation Analysis

Session 8

Module 2: Economics of Climate Change

Slide 1

What is Climate Change Mitigation?

- The greenhouse effect is a natural process which has become a global problem due to excess human emissions of Greenhouse Gases (GHGs)
- Climate change is the physical effects of a GHG build-up
- When GHG concentration = twice the pre-industrial level, the planet will be committed to a warming of 2 - 5º C.
- This could cause major changes in global and regional climate patterns during the next few decades.
- Climate change threatens to cause serious disruption to natural ecosystems and human societies.
- Mitigation is the process through which GHG emissions - and thus the impacts climate change - may be reduced.

Slide 2

Reduction in GHG Emissions Needed to Stabilize Atmospheric Concentrations at Present Levels

Greenhouse Gas:	Reduction Required:
Carbon Dioxide	>60%
Methane	15 - 20%
Nitrous Oxide	70 - 80%
CFC-11	70 - 75%
CFC-12	75 - 85%
HCFC-22	40 - 50%

Source: AAAG (199X)

Slide 3

Reducing Net Emissions

Reductions are made through changes in GHG Sources and Sinks

- Source: A natural or human activity that emits GHGs into the atmosphere. The most important human source of carbon dioxide is fossil-fuel combustion.
- Sink: A part of the biosphere that acts as a stable reservoir for GHGs. The oceans and the terrestrial plants are the most important sinks for carbon dioxide.

Net Emissions = Sources - Sinks

Slide 4

The World's Response to Climate Change

- 1988 - Formation of IPCC
- 1992 - Signing of UNFCCC
- 1997 - Agreement on Kyoto Protocol
- 2001 - New U.S. President withdraws support for Protocol
  - Other nations reach agreement on details of Protocol implementation

Slide 5

UNFCC Commitments (Article 4)

- Three categories of commitments:
  - general commitments that apply to all Parties
  - commitments that only apply to Parties listed in the Annex I
  - commitments that apply to Parties listed in Annex II
- The development of programs containing measures to mitigate climate change is included in the general commitments, and therefore applies to all Parties.

Slide 6

Methods of Climate Change Assessment

- National Inventories of Greenhouse Gases
- Vulnerability Assessments
- Adaptation Analysis
- **Mitigation Analysis**
- Capacity-Building Needs Analysis

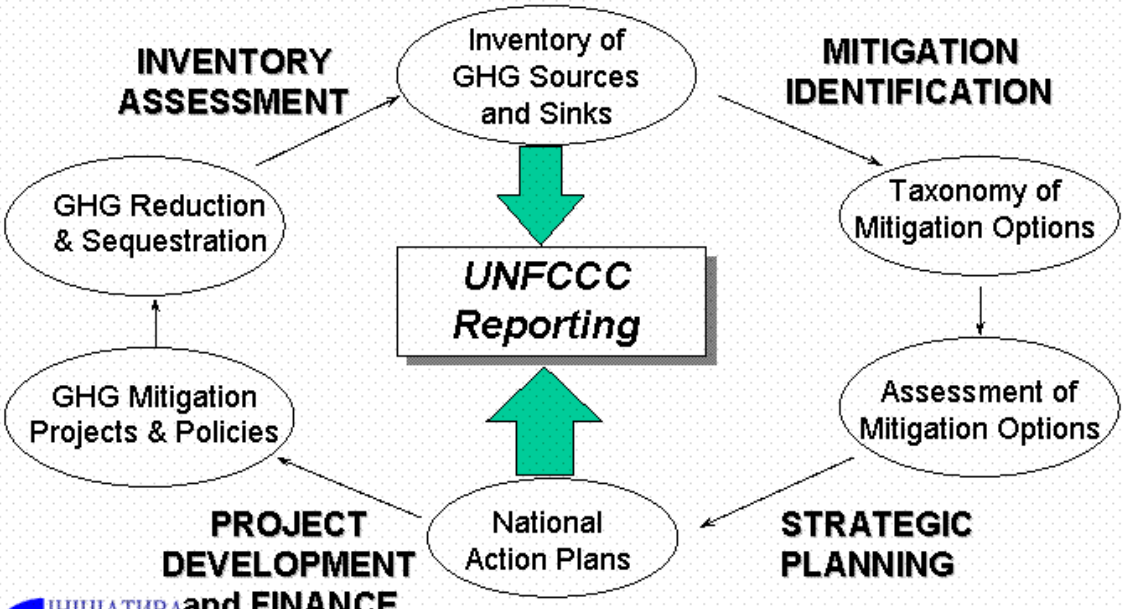
Slide 7

Role of Mitigation Analysis

- To present a set of viable options for reducing or sinking GHGs
- To assess the cost of reducing GHG emissions through each set of options
- To rank these options and use them as building blocks for national or other mitigation strategy

Slide 8

UNFCCC, GHG Inventory and Mitigation



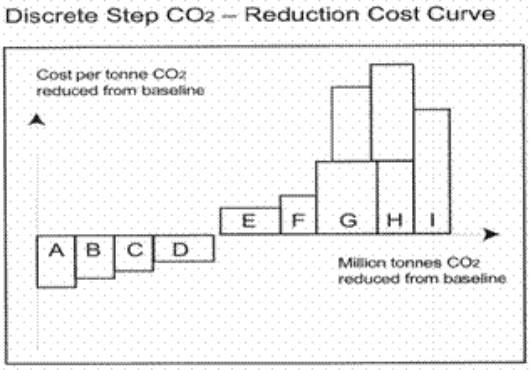
Commitments Specific To Climate Change Mitigation Analysis

- Report periodically on programs to mitigate climate change
- Participate in technology transfer programs
- Promote enhancement of sinks
- Include climate change mitigation in development

Slide 10

Why do Mitigation Analysis?

- The process meets UNFCCC principles and objectives.
- There may be "no regret" or "negative cost" options available that will also have GHG abatement benefits.



- In addition to global environmental benefits, mitigation options may have other national benefits

Slide 11

Current Approach to Mitigation Analysis

- Define the boundaries of the system
- Review National GHG Inventory
- Establish a baseline case/scenario for GHG emission, technology, economy, costs and benefits, etc.
- Identify viable mitigation options that reduce GHG emissions or enhance sinks, *and* meet national development objectives
- Develop a mitigation case/scenario along the same parameters as the baseline, using analytical tools
- Compare baseline and mitigation cases based on costs and benefits

Slide 12

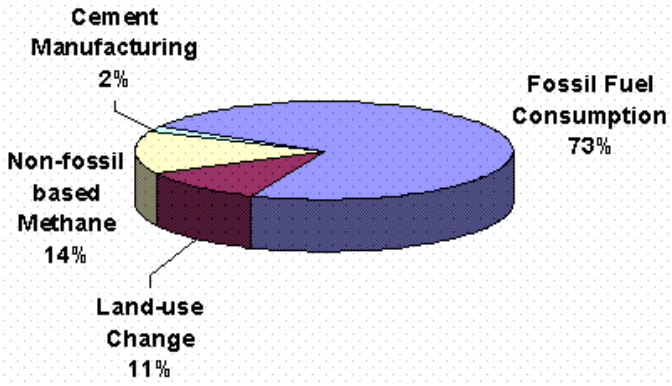
Major Greenhouse Gases

- The six GHGs controlled under the Kyoto Protocol are:
  - carbon dioxide (CO_2)
  - methane (CH_4)
  - nitrous oxide (N_2O)
  - sulphur hexafluoride (SF_6)
  - perfluorocarbons (PFCs)
  - hydrofluorocarbons (HFCs)

Slide 13

Global Sources of GHG Emissions

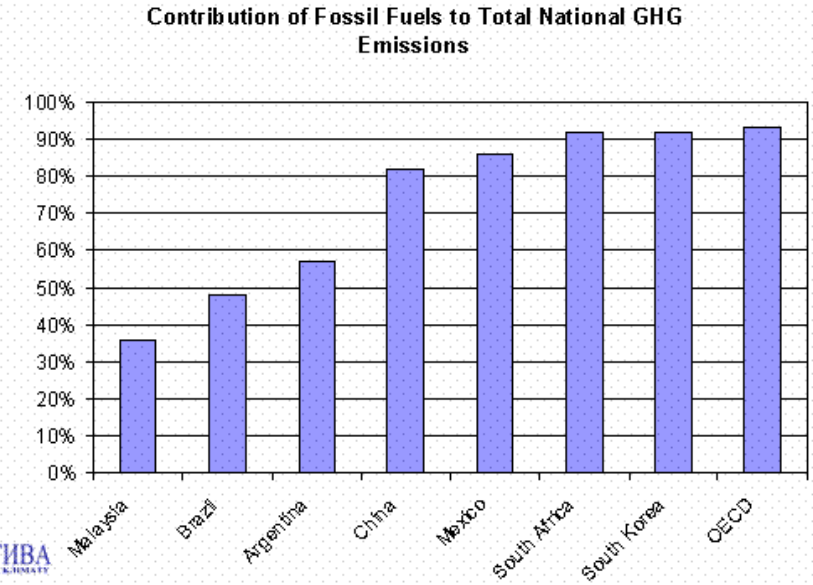
Anthropogenic GHG Emissions, 1991



Slide 14

GHG Emissions from Fossil Fuels

Fossil fuel based emissions dominate national GHG emissions.



Slide 15

Emissions From Energy Activities

- Fuel combustion, production, transport, storage, distribution
- Fuel combustion activities:
  - a) Energy & Transformation Industries
  - b) Industry
  - c) Transportation
  - d) Commercial/Institutional/Residential
  - e) Agriculture/Forestry
  - f) Biomass burned for energy
- Fugitive fuel emission:
  - a) Oil and Natural Gas Systems,
  - b) Coal Mining
- Mitigation options include efficiency improvements and renewable energy technologies

Slide 16

Emissions From Industrial Processes

- Greenhouse gases are by-products of the various production processes, including production of:
  - **Iron and Steel**
  - **Non-ferrous Metals**
  - **Inorganic Chemicals**
  - **Organic Chemicals**
  - **Non-metallic Mineral Products**
  - **Others**
- Mitigation options include efficiency improvements in both energy and materials use.

Slide 17

Emissions From Agriculture
– excluding fuel combustion

- **Enteric Fermentation**
- **Animal Wastes**
- **Rice Cultivation**
- **Agricultural Soils**
- **Agricultural Waste Burning**
- **Savannah Burning**
- Mitigation options include:
  - improved livestock and manure management
  - rice field nutrient and water management
  - fertilizer efficiency
  - conservation tillage

Slide 18

Emissions From Land-use Change and Forestry

- The most important land-use changes that result in CO_2 emissions and removals and release of non-CO_2 trace gases are:
  - Changes in forest and other woody biomass stocks
  - Forest and grassland conversion
  - Abandonment of croplands, pastures, plantation forests, or other managed lands
  - Changes in soil carbon
- Mitigation options include reforestation, enhanced regeneration and forest protection and conservation

Slide 19

Emissions From Waste

- Landfills
- Waste Water
- Human Sewage
- Waste Incineration

- Mitigation options include methane recovery and source reduction through reuse, recycling and composting.

Slide 20

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 9: Key Mitigation Concepts

Overview

General Objectives: By the end of the session, participants should design of mitigation assessment. Specifically, participants should become familiar with:

- Commonly used terms in mitigation analysis
- The base structure and steps involved in conducting a mitigation assessment
- Major criteria used in the evaluation of technologies and policies used in mitigation analysis

Activities: An overhead slide presentation, followed by period of questions and answers

Total Time: 30 - 45 minutes

Materials: Set of 14 OHTs

Key Mitigation Concepts

Session 9

Module 2: Economics of Climate Change

Slide 1

Definitions of Commonly Used Terms and Concepts in Mitigation Analysis

- Mitigation
- Abatement
- Mitigation Analysis
- Abatement Costing
- Baseline
- Baseline Definition
- Baseline Scenario
- Mitigation Scenario
- Emissions Inventories
- Emission Factors

Slide 2

Terms and Concepts (ctd)

- Assumptions
- Abatement Cost Curve
- Abatement Cost Function
- Technology Assessment
- Levelized Cost
- Reduction Target
- Reporting Period
- Base-year
- Sources And Sinks
- Negative Cost Options
- Transaction Costs

Slide 3

Preparing For a Mitigation Assessment

- Set level (project, sector, national)
- Define the time frame of the assessment
- Define the scope of the assessment
- Define results that meet the users' needs
- Select approaches that are consistent with data availability and expertise

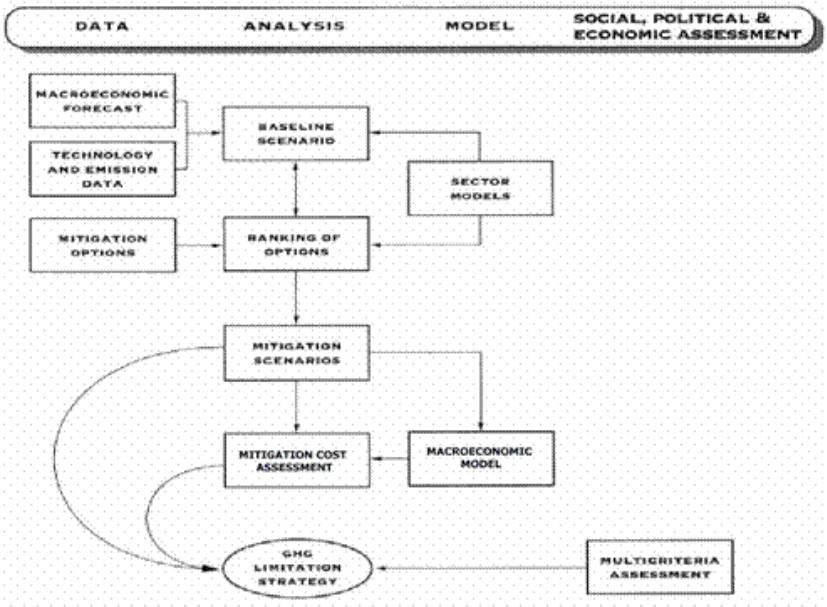
Slide 4

Steps In Mitigation Analysis

- There are Seven Key Steps in Mitigation Analysis:
  1. Comprehensive evaluation of national, social, and economic development circumstances
  2. Review of GHG inventory
  3. Baseline scenario projection
  4. Assessment of mitigation options (technology and policy)
  5. Mitigation scenario(s) projection(s)
  6. Mitigation cost assessment
  7. Assessment of implementation issues

Slide 5

Structure of Mitigation Analysis



Slide 6

Review National GHG Inventory Data to Identify Key Sources and Sinks

- The review is intended to show which sectors are likely to produce significant change through mitigation
- Inventories do *not* take into account future or planned development
- Inventories *may* be able to:
  - show the source and quantity of GHG emissions
  - indicate the factors contributing to these levels
  - provide a good guide to mitigation options within the existing development pattern

Slide 7

Major Anthropogenic GHG Sources and Sinks

- SOURCE: Six major categories of human activities that result in GHG emissions:
  - energy production, transport, distribution, storage and consumption
  - certain industrial processes
  - use of solvents
  - certain agricultural practices
  - land-use change and forestry activities that remove vegetation
  - waste management
- SINK: Certain human activities result in the removal or sequestration of GHGs. These are classified under:
  - land-use change and forestry activities that enhance vegetation

Slide 8

Sample Inventory:

SOURCE		CO_2 (Gg)	CH_4 (Gg)	N_2O (Gg)	NOx (Gg)	CO (Gg)
FUEL ACTIVITIES	CO_2 FROM ENERGY	3346.9				
	BIOMASS, NON-CO_2		24.9	0.1	2.8	174.9
FUGITIVE FUEL EMISSIONS	COAL PRODUCTION		0.1			
INDUSTRY	CEMENT PRODUCTION	234				
AGRICULTURE	LIVESTOCK		83.5			
	RICE CULTIVATION		58.7			
	SAVANNAH BURNING		0.0	2.1	48.4	26.3
	AGRICULTURE RESIDUES		0.7	0.0	0.5	14.7
LAND-USE CHANGE AND FORESTRY	CHANGES IN FOREST AND OTHER WOODY BIOMASS STOCKS	28167.2				
	ON-SITE BURNING OF FORESTS		52.8	0.4	8.6	462.4
	ABANDONMENT OF MANAGED LANDS	-26355.4				
WASTE	SOLID WASTE DISPOSAL SITES		68.9			
	MUNICIPAL WASTEWATER		14.8			
TOTAL		**5392.7**	**304.5**	**2.6**	**60.3**	**678.3**
GWP		**1**	**21**	**310**	-	-
TOTAL CO_2 Equiv.		**5392.7**	**7460.25**	**832**	-	-

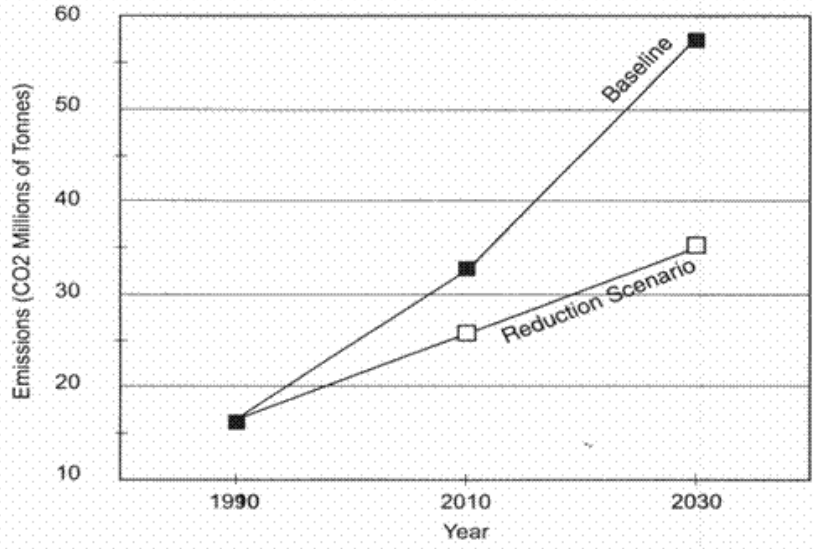
Slide 9

Key Parameters of Baseline and Mitigation Scenarios

- Baseline Scenario
  - Assumptions on social and economic parameters
  - Technology development and diffusion rate in the market
  - Natural resource prices
  - Domestic and international policy environment
- Mitigation Scenario
  - The above baseline parameters plus
  - Availability and market adoption rate of mitigation options
  - Mitigation scenario objectives
- *Developing scenarios is a complex task.*

Slide 10

Sample Comparison of Scenarios



Slide 11

Evaluation of Technologies and Policies

Economic and Social Criteria

- Cost-effectiveness
  - Average and marginal costs
- Project-level considerations
  - Capital/operating costs, opportunity costs, incremental costs
- Macro-economic considerations
  - GDP, jobs created or lost, effects on inflation or interest rates, implications for long-term development, foreign exchange and trade, other economic benefits or drawbacks
- Equity considerations
  - Differential impacts on countries, income groups and/or future generations

Slide 12

Evaluation of Technologies and Policies

Environmental Criteria

- **GHG reduction potential**
  - metric tons of carbon equivalent
- **Other environmental considerations**
  - emissions reduction of other gases and particulates
  - effect on biodiversity
  - soil conservation
  - watershed management
  - indoor air quality, etc.

Slide 13

Evaluation of Technologies and Policies

Institutional Criteria

- Administrative burden
  - Institutional capabilities for information collection, monitoring, enforcement, permitting, etc.
- Political considerations
  - Capacity to pass through political and bureaucratic processes and sustain political support
  - Consistency with other public policies
- Replicability
  - Adaptability to different geographical and socio-economic-cultural settings

Slide 14

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 10: Mitigation Methods

Overview

General Objectives: By the end of the session, participants should have a basic understanding of the two major approaches in mitigation assessment. Specifically, the audience should become familiar with:

- The criteria to use in selection of modeling approach over another
- Types of bottom-up and top-down modeling tools available
- The data inputs required for each type of approach

Activities: An overhead slide presentation, followed by period of questions and answers

Total Time: 35 to 45 minutes

Materials: Set of 17 OHTs

Mitigation Methods: Selecting an Approach

Session 10

Module 2: Economics of Climate Change

Slide 1

Review: Current Approach to Mitigation Analysis

- Define the boundaries of the system
- Review National GHG Inventory
- Establish a baseline case/scenario for GHG emission, technology, economy, costs and benefits, etc.
- Identify viable mitigation options that reduce GHG emissions or enhance sinks, *and* meet national development objectives
- Develop a mitigation case/scenario along the same parameters as the baseline
- Compare baseline and mitigation cases based on costs and benefits

Slide 2

Steps in Developing an Approach

- **FIRST:** Decide on the methodological approach to be adopted for the analysis
- **SECOND**: Select the analytical tool/model to be used in the analysis
- **THIRD**: Bear in mind unique considerations of the analysis (e.g., data availability, skills required)

Slide 3

Selecting a Methodological Approach

- **There are two basic approaches which have been used for mitigation analyses to date:**
  - **One is the bottom-up approach**
  - **The other is the top-down approach**

Slide 4

Applications of the Bottom-up Approach

- Bottom-up approaches are suitable for:
  - project based climate change mitigation analysis
  - integration of independent technological interventions
  - short-term assessment of climate change mitigation
  - cases with insufficient macroeconomic data

Slide 5

Strengths and Weaknesses of the Bottom-up Approach

- STRENGTHS
  - Shows measurable emission reduction potential on a project-by-project basis.
  - Shows measurable mitigation cost by each proposed activity.
  - Answers high priority short-term questions.
- WEAKNESSES
  - Methods to account for project-to-project interaction have not yet been formalized.
  - Too specific for long-term assessments of mitigation.
  - Cannot answer macroeconomic questions related to mitigation actions.

Slide 6

Best Conditions For Applying Bottom-up Approach

- Bottom-up approaches are most useful where:
  - There is insufficient historical (macro-economic) data for trend analysis
  - There are dominant short-term development problems (such as in the energy sector)
  - There are major efficiency improvement options
  - A single dominant economic sector is emitting the majority of GHGs
  - There is insufficient expertise and/or data for macroeconomic modeling

Slide 7

Bottom-Up Models for Mitigation Analysis

- Accounting Frameworks (e.g. LEAP)
- Optimization Models (e.g. MARKAL)
- Simulation Models (e.g. ENPEP)

Slide 8

Types of Data Required for Bottom-Up Mitigation Analysis

- Technology: plant capacities, efficiency, fuels used/produced, lifetime, capacity factor
- Costs: fuel costs, capital, operating and maintenance (fixed and variable), program administration costs, other externality costs (e.g. non-GHGs)
- Market: installed capacity and vintage of plants in base year
- Environmental: Emission coefficients for CO2, CH4
- Trends: Technical potential, market penetration rates

Slide 9

Outputs of Bottom-Up Analysis

- Amount of GHG emissions reduced (tons) by each option
- Cost of the investment (for the mitigation technology) relative to each ton of GHG reduced ($/ton CO_2)
- These costs are used to construct:
  - Mitigation cost curves
  - Mitigation scenario results (e.g. total % reduction relative to baseline)

Slide 10

Limits to Bottom-Up Approach: Macroeconomic Questions

- Only captures direct economic costs, *not* impacts on GDP growth, employment, industrial structure, etc.
- Estimating macroeconomic effects requires linkage to macroeconomic model
- Feedbacks of macroeconomic effects may affect energy system.
- In a general equilibrium approach, whole system is interdependent.
- Such models are highly complex.

Slide 11

General Description Of Top-down Approach

- **The top-down approach:**
  - involves macroeconomic modeling
  - involves complex econometric models
  - relies on a broad economic forecast
  - accounts for interaction between options (scenarios)
  - allows for regional assessment of climate change mitigation (coupling of options and economies)
  - requires data on linkages between economic sectors (usually input-output tables)

Slide 12

Types of Top-down models

- Simple macroeconomic (econometric):
  - suitable for short-term analysis (up to 10 years)
- Input-output
  - captures intersectoral feedbacks but not structural changes in economies
- Computable general equilibrium
  - captures structural changes; assumes market clearing; suitable for full market economies (e.g. GREEN, Jorgenson-Wilcoxen, Tellus model)

Slide 13

Strengths and Weaknesses of the Top-down Approach

- STRENGTHS
  - Can incorporate long-term effects of greenhouse gas mitigation
  - Captures cross sectoral effects of climate change mitigation measures
  - Allows for definition of regional scenarios
- WEAKNESSES
  - Not applicable to data deficient situations
  - Cannot span periods of major economic reform (as seen in many EIT and developing countries)
  - Has a high demand for analytical skills development
  - Analysis is usually wider than "field of view"

Slide 14

INPUTS (data requirements) of Top-down Analyses:

- Autonomous efficiency coefficients
- Elasticities
- Trends in economic activities

OUTPUTS of Top-down Analyses:

- Carbon reduction
- Impact on GDP
- Jobs/Market transformation

Slide 15

Best Conditions For Applying the Top-down Approach

- Top-down methods are best suited for:
  - Situations with adequate economic data
  - Economies with a low level of policy change (mature economies, such as developed countries)
  - Economies with close coupled sectors (industrialized countries)
  - Situations where macroeconomic policy options are dominant
  - Situations where analytical expertise is available

Slide 16

For more information

- US Country Studies Program, Guidance for Mitigation Assessment: Version 2.0.
- UNEP Greenhouse Gas Abatement Costing Studies, Phase Two, Appendix: Guidelines by UNEP Collaborating Centre on Energy and Environment at Riso National Laboratories, Denmark.

Slide 17

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 11: Introduction to market mechanisms in ecology

Overview

General Objectives:

Session 1 introduces market-oriented environmental management. It is intended to give a broad overview of the transition from command/control regulation towards a regulatory system that utilizes economic instruments. In this context, the Kyoto Protocol flexibility mechanisms can be seen as "quantity-based" (as opposed to price-based) instruments.

This session will, of necessity, rely upon the experience and knowledge of the individual who makes the presentation. It would be helpful if that individual addresses the following topics, which were included in the initial training program offered in July 2000:

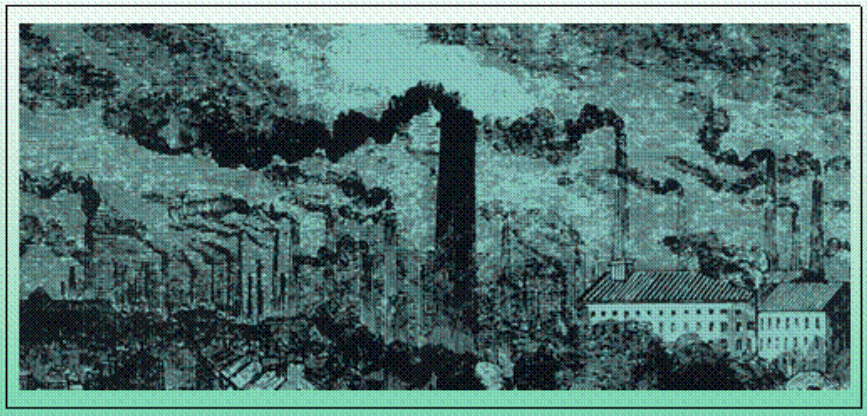
- The historical basis for command/control;
- The engineering approach to pollution control;
- The development of marginal cost and benefit curves;
- Setting environmental goals using economics;
- Utilizing price-based mechanisms to achieve these goals;
- Utilizing quantity-based mechanisms to achieve these goals;
- The historical development of U.S. quantity-based mechanisms and emissions trading:
    - The Emissions Trading Program
    - The Acid Rain Control Program
    - The NOx Budget Control Program
- A brief introduction to the Kyoto Protocol Flexibility Mechanisms as quantity-based mechanisms;
- Summary of market-based environmental management.

By the end of the session, participants should thus have a basic understanding of:

- how market-oriented environmental management operates;
- recent experience in utilizing it; and
- the role of the Kyoto Protocol flexibility mechanisms as economic instruments.

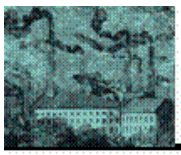
From Mandates to Markets:

Introduction to Market Mechanisms in Ecology

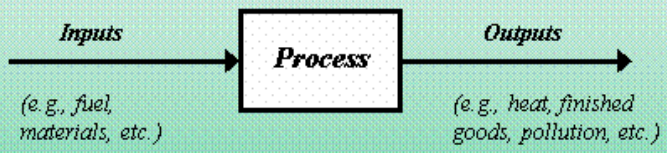


Session 11
Module 2: Economics of Climate Change

Slide 1



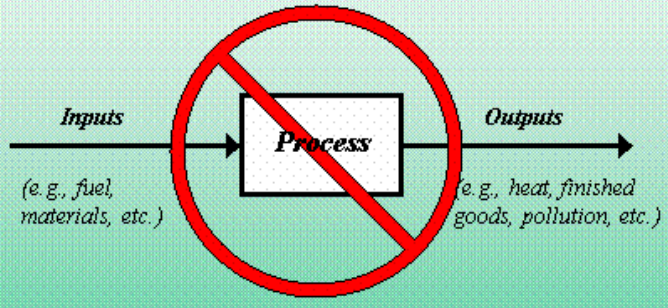
An Engineer's View



Slide 2

Pollution Control Options

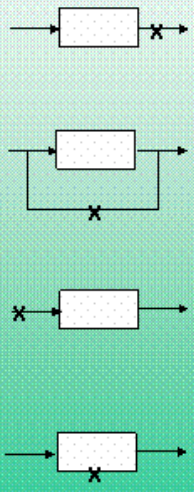
A. Prohibition



Slide 3

Pollution Control Options

B. Engineers' Approach



Emission standards
limit the amount of pollution being emitted (e.g., tons/year, pounds per day, etc.)

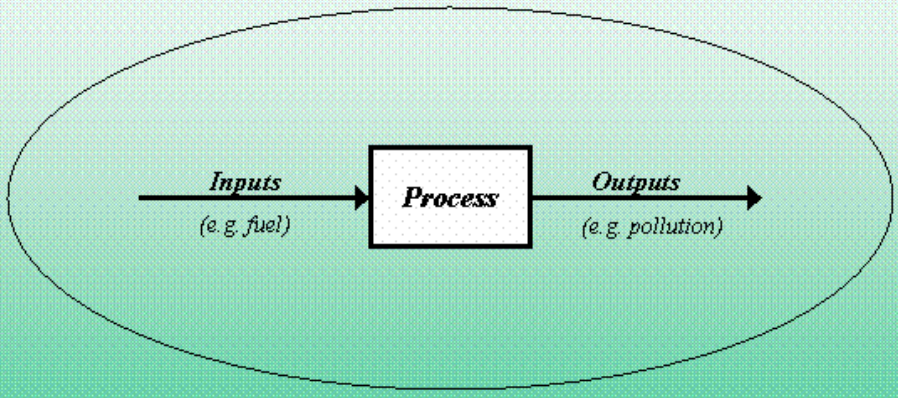
Performance standards
limit the amount of pollution being emitted based on the amount of material being processed (e.g., pounds of SO_2 per million BTUs of heat input from the fuel source).

Input/Product standards
limit the quality of materials, e.g. fuels, which can be used (e.g. limits on sulfur content of distillate and fuel oils).

Design standards
tell the polluter how the process must be designed (e.g., to minimize wastage of materials).

Slide 4

But Where is Environment?



Slide 5

Command/Control Regulation

Goals

physical modeling

Environmental Quality Standards

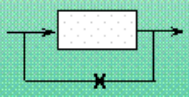
Regulatory Means

A. Prohibitions

B. Technology-Based Standards

Emission Standards

Performance Standards



Input/Product Standards

Design Standards

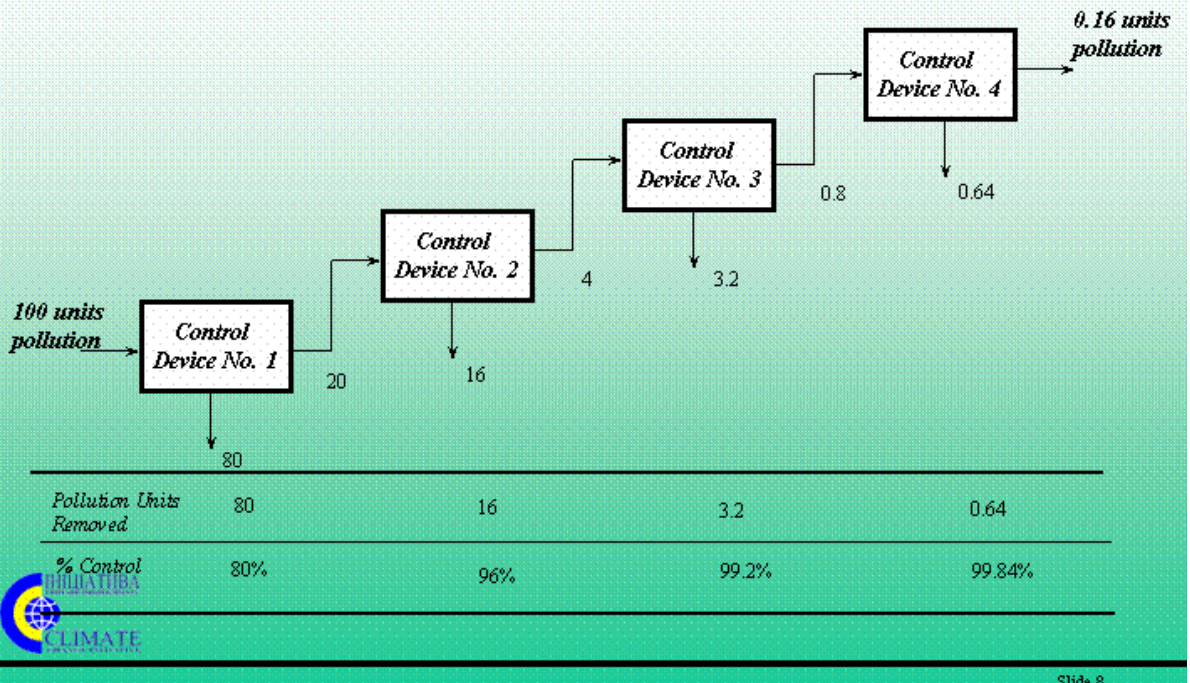
Source: Raufer, 1998

Slide 6

Where is Economics?

Slide 7

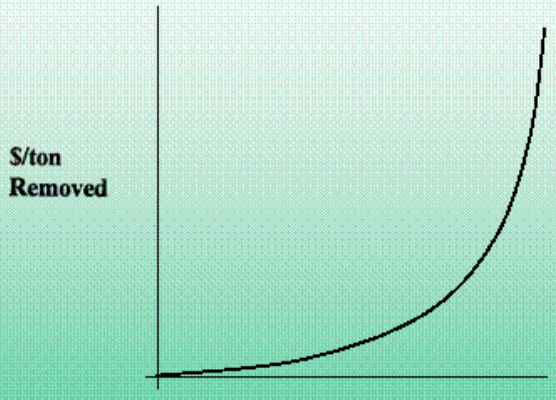
Incremental Pollution Control Improvements



Pollution Units Removed	80	16	3.2	0.64
% Control	80%	96%	99.2%	99.84%

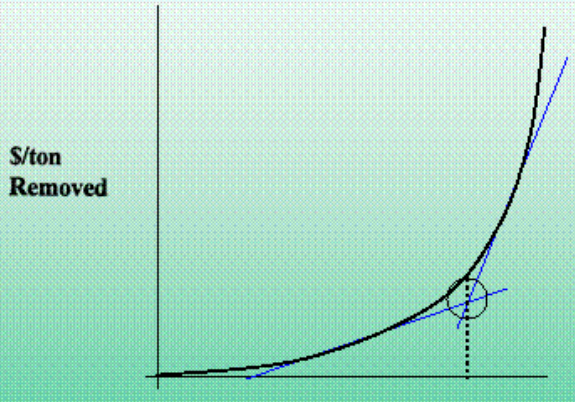
Slide 8

MC Curve



Slide 9

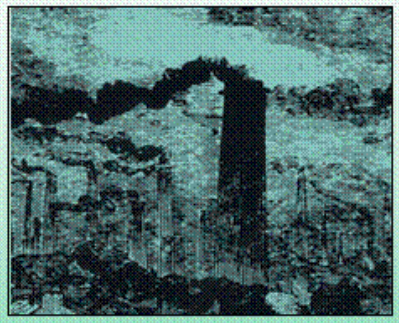
"Kink" in Curve

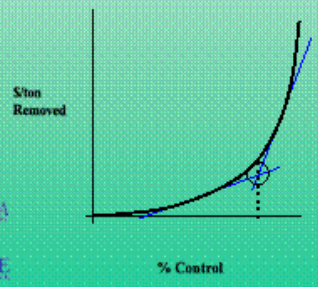


Slide 10

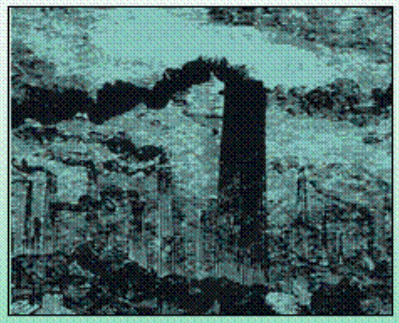
The Economists' Response?

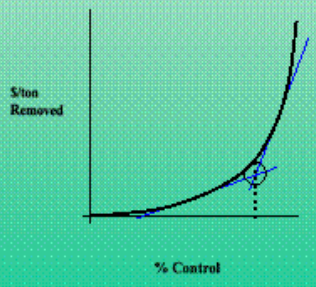
Methyl Isocyanate





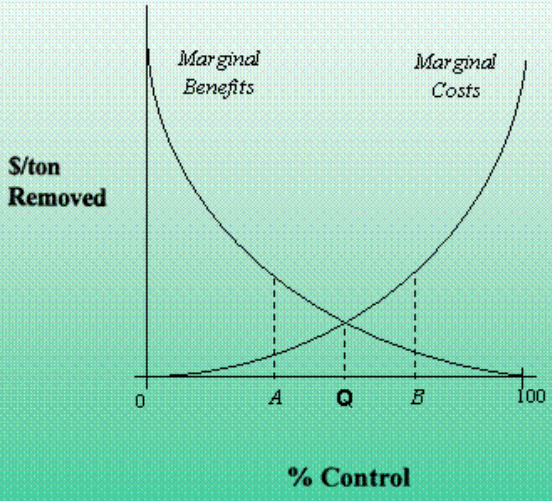
Carbon Dioxide



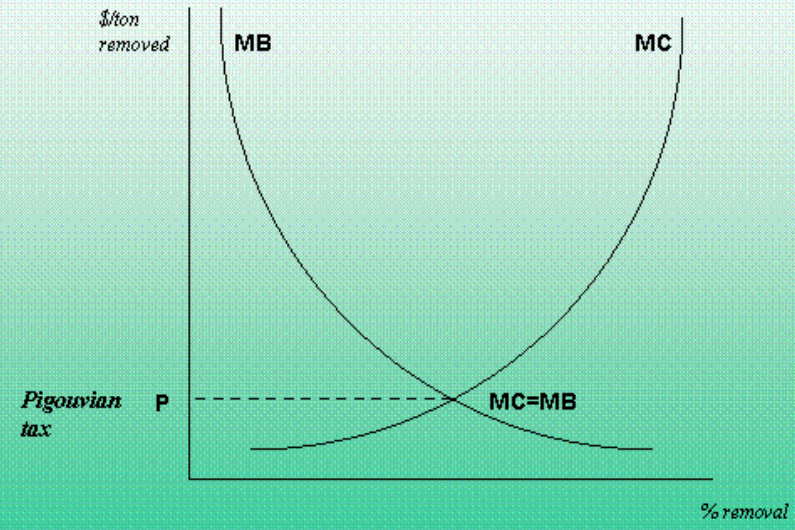


Slide 11

Marginal Costs and Benefits

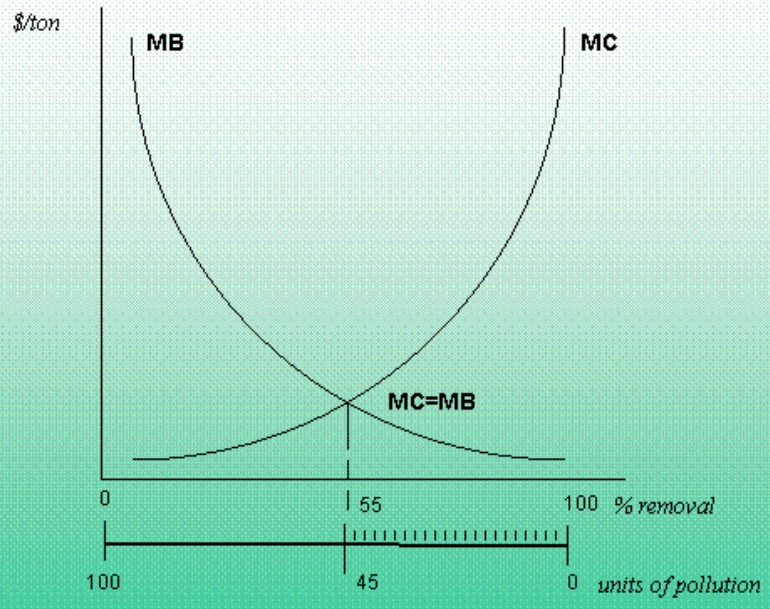


The Price-Based Approach: Pigouvian Taxation



Slide 13

The Quantity-Based Approach: Marketable Permits

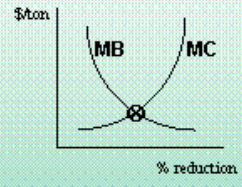


Slide 14

Economic Regulatory Approach

Goals

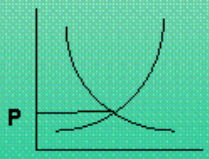
Marginal Costs (MC) = Marginal Benefits (MB)



Regulatory Means

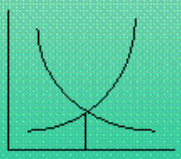
Pollution Taxes (Price-based)

Pigouvian taxation



Pollution Markets (Quantity-based)

Marketable Permits

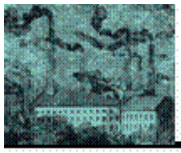


Slide 15

Key Properties of Economic Mechanisms

- Governments focus on environmental goals, rather than stack-by-stack means.
- Economic efficiency gives comparable levels of environmental quality for lower costs.
- Efficiency can influence goal setting (i.e., savings targeted towards environment).
- Every ton of pollution has costs, giving facilities an incentive for reduction.

Slide 16

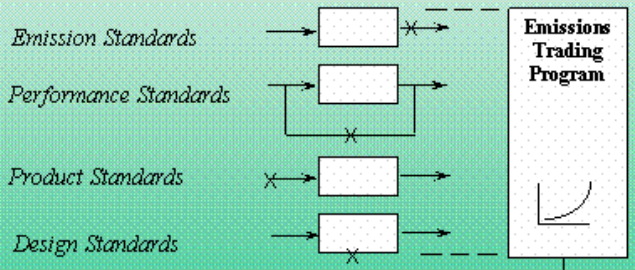


Emissions Trading Program

Goals — *Environmental Quality Standards*

Regulatory Means

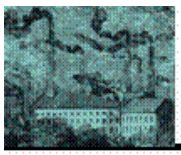
1. *Prohibitions*
2. *Technology-Based Standards*



Brokerage Opportunities

Emission Reduction Credits (ERCs)

Slide 17



Acid Rain Control Program

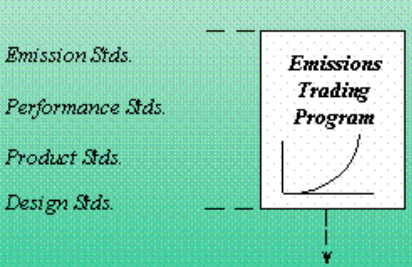
Goals — *Localized SO_2 Levels*; *Total SO_2 Loading*

Regulatory Means

1. *Prohibitions*
2. *Technology-based Standards*

Pollution Markets (Q-based)

Nation-wide Market (Allowance Tracking System)



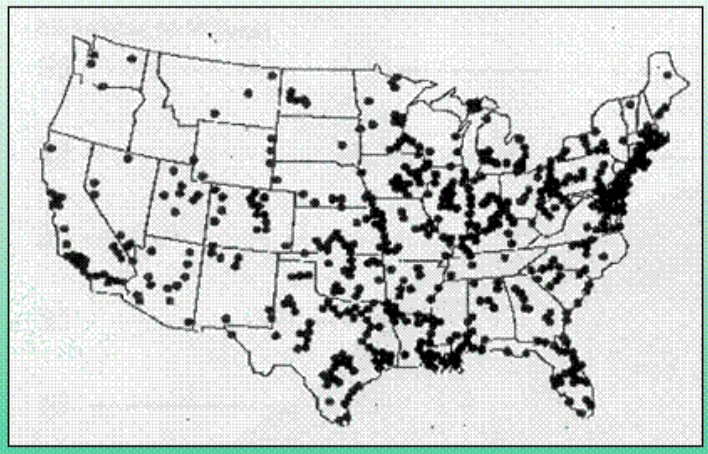
Brokerage Opportunities

ERCs

Emission Allowances

Slide 18

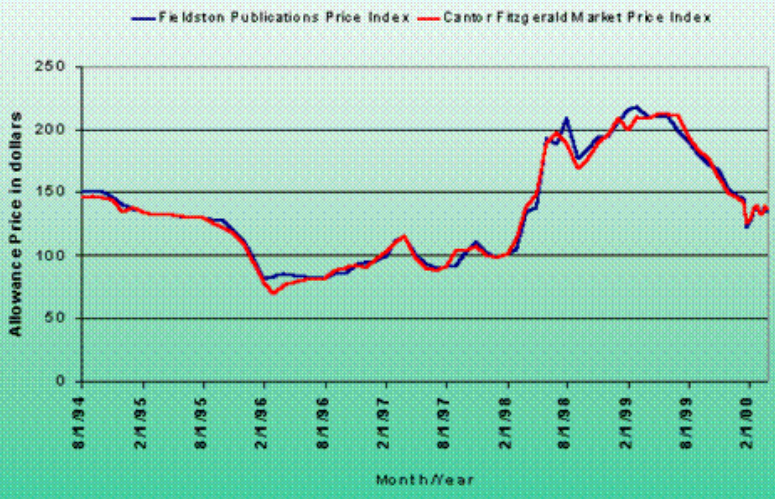
Acid Rain Control Affected Sources



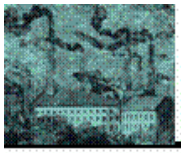
2000+ Electric Utility Units

Slide 19

Monthly Average Price of Sulfur Dioxide Allowances



Slide 20



Ozone Control Program

Goals — *Environmental Quality Standards*

Regulatory Means

1. *Prohibitions*
2. *Technology-based Standards*
   - *Emission Stds.*
   - *Performance Stds.*
   - *Product Stds.*
   - *Design Stds.*

Emissions Trading Program

Pollution Markets (Q-based)

City/Regional Markets

Examples:
Northeast U.S. "NOx Budget"

Los Angeles "RECLAIM" Program

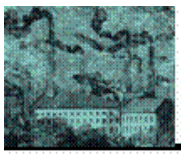
Illinois "Clean Air Market"

Brokerage Opportunities

ERCs & Discrete Emissions Reductions (DERs)

NOx/VOC Emission Allowances

Slide 21



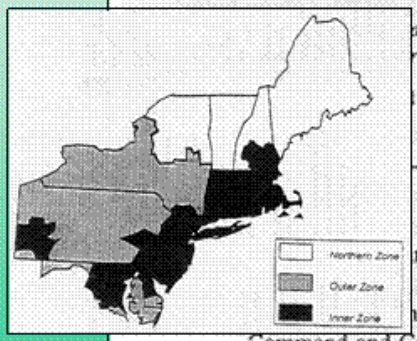
NOx Budget

The NOx Budget: market-based control of tropospheric ozone in the northeastern United States

Alex Farrell [a,*], Robert Carter [b], Roger Raufer [b]

arvard University, Cambridge, MA, USA
rsity of Pennsylvania, Philadelphia, PA, USA

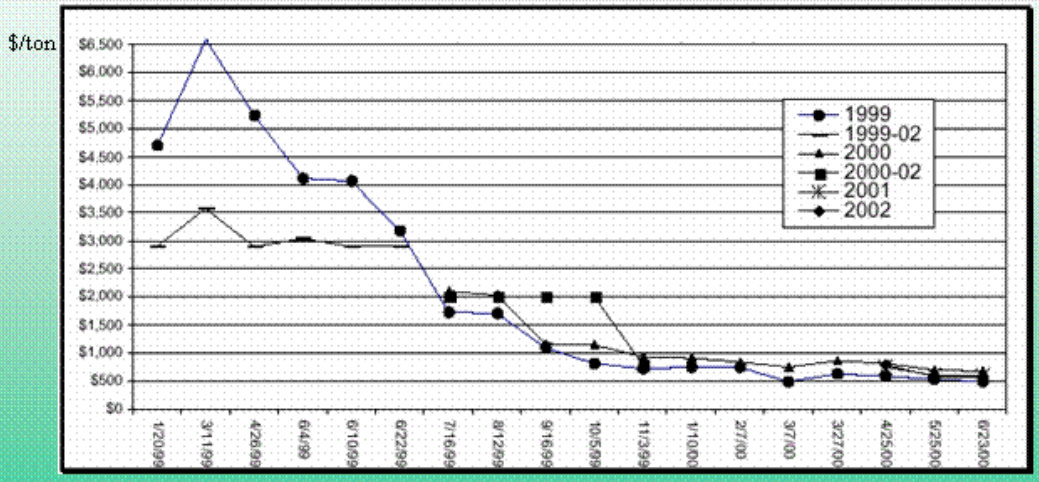
998; revised 12 August 1998; accepted 21 August 1998



rketable emissions allowance system currently being adopted US to reduce tropospheric ozone concentrations to healthful ner. Oxides of nitrogen (NOx) are currently regulated within mmand and Control (CAC) framework. The introduction of a market-based

Slide 22

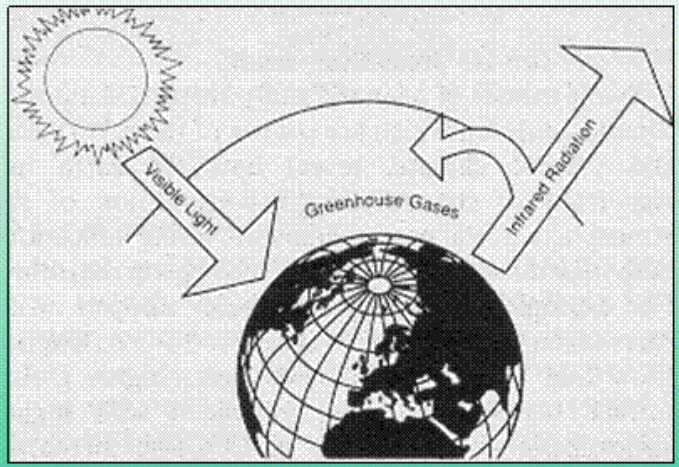
NOx Budget Allowance Prices



Source: Cantor Fitzgerald, June '00

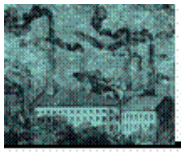
Slide 23

The Greenhouse Effect



Source: GAO, '90

Slide 24



Global Warming P vs. Q Debate

FOREIGN AFFAIRS
Founded 1922

Toward a Real Global Warming Treaty

Richard N. Cooper

THE CHALLENGE AFTER KYOTO

In December 1997 the world's nations met in Kyoto to grapple with the problem of global warming. The Kyoto conference garnered a wide variety of assessments, ranging from "a notable success"

FOREIGN AFFAIRS · *March/April 1998*

Response

Stick with Kyoto

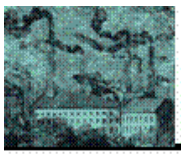
A Sound Start on Global Warming

Stuart Eizenstat

of the recent Kyoto accord, ooper notes that mitigating e will not be easy ("Toward Warming Treaty," taxes. But his belief that ag a tax might be easier than se targets is out of touch with Even if it could be arranged

FOREIGN AFFAIRS · *May/June*

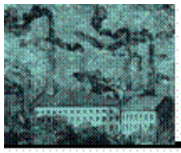
Slide 25



Q-Based Kyoto Flexibility Mechanisms

- Article 6: Joint Implementation
  - Transfer of "emission reduction units"
  - Project-based, effective 2008-2012
- Article 12: Clean Development Mechanism
  - Transfer of "certified emission reductions"
  - Banked after 2000, used during 2008-2012
- Article 17: International emissions trading
  - Transfer of "assigned amount"
  - Annex I countries, 2008-2012

Slide 26



GHG Q-Based Program

Goals

Reduction of GHG Emissions

Regulatory Means

1. Prohibitions
2. Technology-based Standards

Emission Stds.
Performance Stds.
Product Stds.
Design Stds.

Baseline Conditions

JI & CDM GHG Improvements

Pollution Markets (Q-based)

International Emissions Trading

Annex I Countries

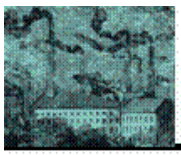
"Hot Air"

ERUs & CERs

AAUs

Brokerage Opportunities

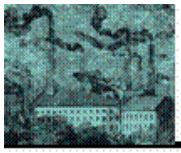
Slide 27



Planned and Ongoing AIJ & JI Projects

Source: JI Quarterly, Dec. '99

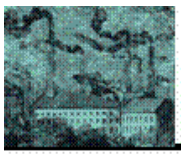
Slide 28



Thirty-Five Years of EM Experience

- Command/control regulation won the early battles.
- Economics became increasingly important as societies climbed the marginal cost curve.
- A hybrid regulatory system has developed.

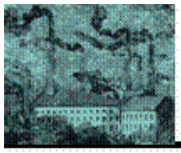
Slide 29



Thirty-Five Years of EM Experience

- Environmental goals set under the command/ control approach, but increasingly employing economic regulatory means.
- The U.S. tends to prefer quantity-based economic mechanisms.
- European and other countries tend to prefer price-based mechanisms.

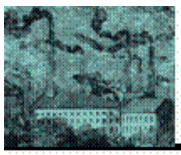
Slide 30



Thirty-Five Years of EM Experience

- The transition has been gradual, with incremental improvements to increase economic efficiency.
- There has been an increased reliance on advanced technological systems (i.e., CEMs) to measure emissions.
- The economic mechanisms have relied on the regulatory infrastructure established under the command/control framework.

Slide 31



Thirty-Five Years of EM Experience

- The physical characteristics of the pollutant should influence the selection of the economic instrument.
- Broader pollutant markets work better.
- The future will increasingly rely on economic mechanisms.

Slide 32

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 12: History of Emission Trading in the US and Future Applications

Overview

- **General Objectives:**

  Session 12 is an introduction to the design and regulation of emissions markets, from the perspective of a governmental official responsible for implementing such a program. It seeks to provide participants with an understanding of the concerns of such a regulator, to insure that the markets provide legitimate and real emissions reductions.

  Topics that should be addressed include:

  - Setting environmental goals
  - Collecting and verifying emissions data
  - Recording market transactions
  - Conducting compliance checks
  - Enforcing penalties for non-compliance
  - Establishing monitoring and reporting systems
  - Evaluating regulatory performance

  By the end of the session, participants should have a basic understanding of the following:

  - A regulator's perspective on how environmental markets should work
  - The critical design elements necessary to ensure that such markets lead to real emission reductions

- **Activities:** Presentation, followed by period of question and answer

- **Total Time: 60 minutes**

History of Emission Trading in the US and Future Applications

Session 12
Module 2: Economics of Climate Change

Main points

- Evolution of emission trading in the US
- Design and results of US SO_2 Emission Trading Program
- Next generation of emission trading

Slide 2

Background: Traditional Regulation of Emissions

- Traditional air pollution control requirements
  - Technology requirements - Air quality benefits were achieved, but costs were high and there were few incentives for innovation or for sources to go beyond environmental requirements.
  - Emission rates - Allowed some flexibility for sources to choose controls but did not ensure a specific level of environmental protection since sources could increase production.

Slide 3

Adding Flexibility to Reduce Costs and Increase Benefits

- Early emission trading (bubbles, offsets, ERCs) added flexibility but...
  - High transaction costs.
    - » Each trade required extensive study to develop baselines.
    - » Each trade was negotiated then extensively reviewed by EPA to ensure net emission reduction.
  - Low satisfaction.
    - » Anyway credits: environmental groups did not want credit granted for actions taken by companies that would have been taken regardless of environmental impacts.

Slide 4

SO_2 Cap and Trade Program: A New Approach

- Set goals in terms of allowable emissions
- Reduced and capped total emissions, ensuring attainment and maintenance
- Required measurement and reporting of all emissions

Slide 5

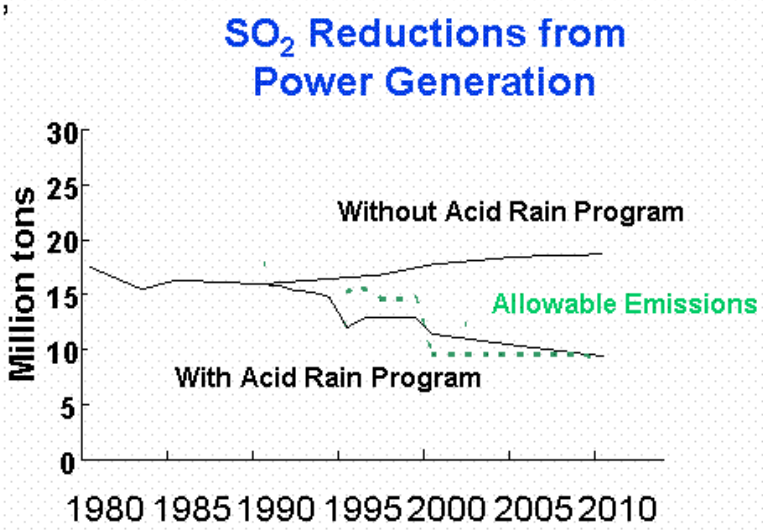
SO_2 Cap and Trade Program: A New Approach (continued)

- Allowed compliance flexibility, including emission trading
  - Encouraged innovation
  - Reduced costs
- Established automatic financial penalties and allowance reductions to assure compliance
- Retained requirements to protect local air quality, regardless of trading

Slide 6

Goal of SO_2 Program as Directed by Congress in 1990

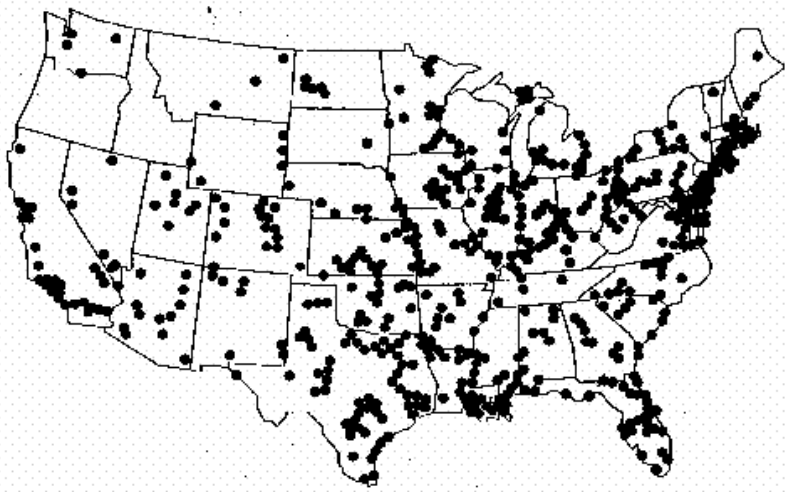
- Protect ecosystems, materials, visibility and public health from the effects of acid rain.
- Reduce SO_2 emissions by 8.5 million tons from power generation through "cap and trade" mechanism.



Slide 7

Assigning Responsibility

Over 2,000 sources affected



Slide 8

Operating the Program: Source Responsibilities

- Sources develop compliance strategy
  - fuel switching, SO_2 scrubbers, efficiency, renewables, trading
- Sources monitor & report all hourly emissions
  - install and maintain monitors (coal, oil, gas)
  - daily, quarterly, and annual performance tests
  - submit hourly emissions data and performance test results to EPA quarterly
- Sources may trade allowances, but must hold sufficient allowances to cover annual emissions

Slide 9

Operating the Program: EPA Role

- Collect, verify, and publish emissions data
- Record official allowance transfers and account balances
- Conduct annual compliance check (reconciliation)
- Enforce penalties for non-compliance

Slide 10

Emissions Monitoring and Reporting

Source installs and maintains monitoring systems

Source electronically submits hourly emissions data (SO_2, NO_X, CO_2) each quarter

EPA /States audit monitoring systems

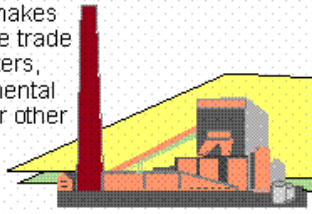
EPA provides feedback to source

EPA processes, quality assures, and reports data

Slide 11

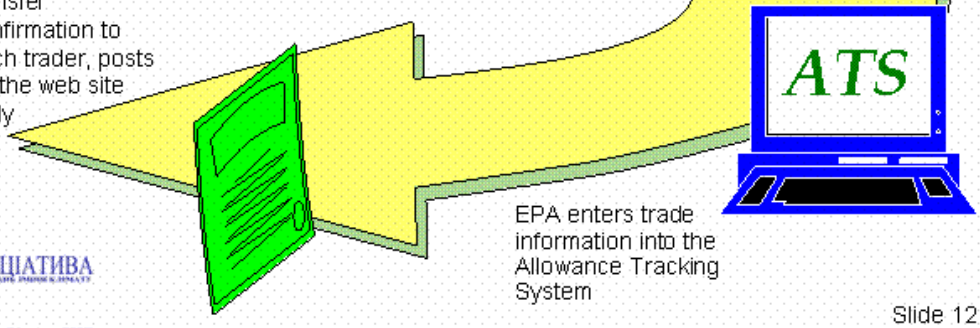
Allowance Transfer Process

Source makes allowance trade with brokers, environmental groups,or other sources



Then mail trade information to EPA

EPA sends transfer confirmation to each trader, posts on the web site daily



EPA enters trade information into the Allowance Tracking System

Slide 12

How was the emission trading market created?

- Market was created to reduce costs (for sources, government and consumers)
- EPA established rules for the market:
  - stringent monitoring and reporting
  - allowance accounting and transfer procedures
  - flexibility in compliance options
- EPA developed tracking systems (ATS, ETS)
- Trades take place among sources/brokers on the telephone, then registered in ATS
- Foundation for market is confidence:
  - that the government subjects all sources to the same compliance obligations and enforcement penalties

Slide 13

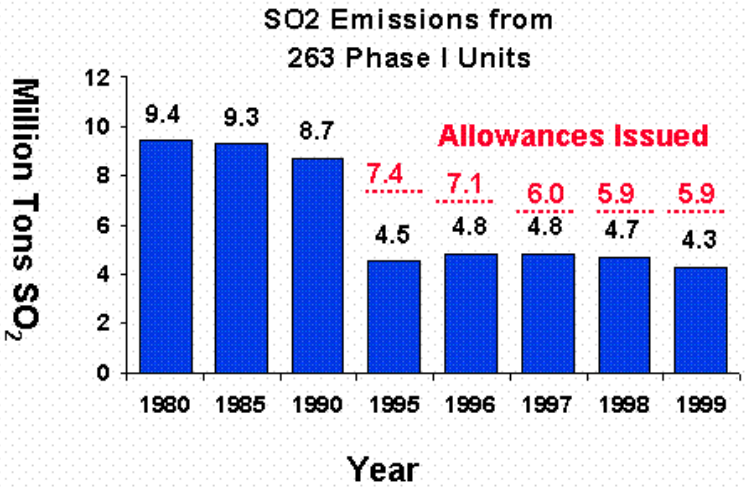
Determining and Ensuring Compliance

- Annual Reconciliation
  - EPA compares allowances (ATS) with actual emissions (ETS) to determine compliance (sources must have one allowance for each ton of SO_2 emitted)
  - After December 31, sources have 60 days to complete final trades
- Enforce penalties for excess emissions
  - Automatic offset (deduction of allowances from next year's account)
  - Automatic financial penalty--currently $2,682/ton
  - Additional civil and criminal penalties

Slide 14

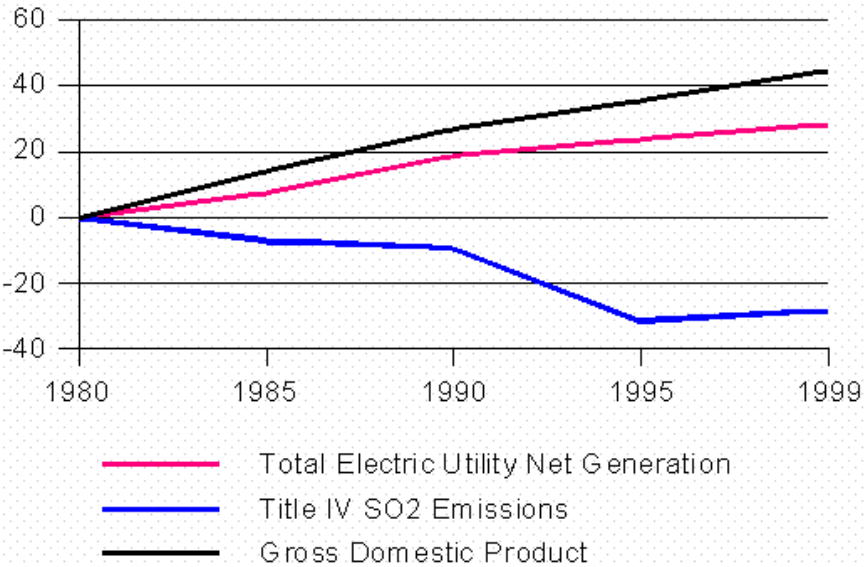
Results: Phase I Emissions

- Emission reductions began on time
- Sources have achieved 100% compliance
- Reductions were greater than expected



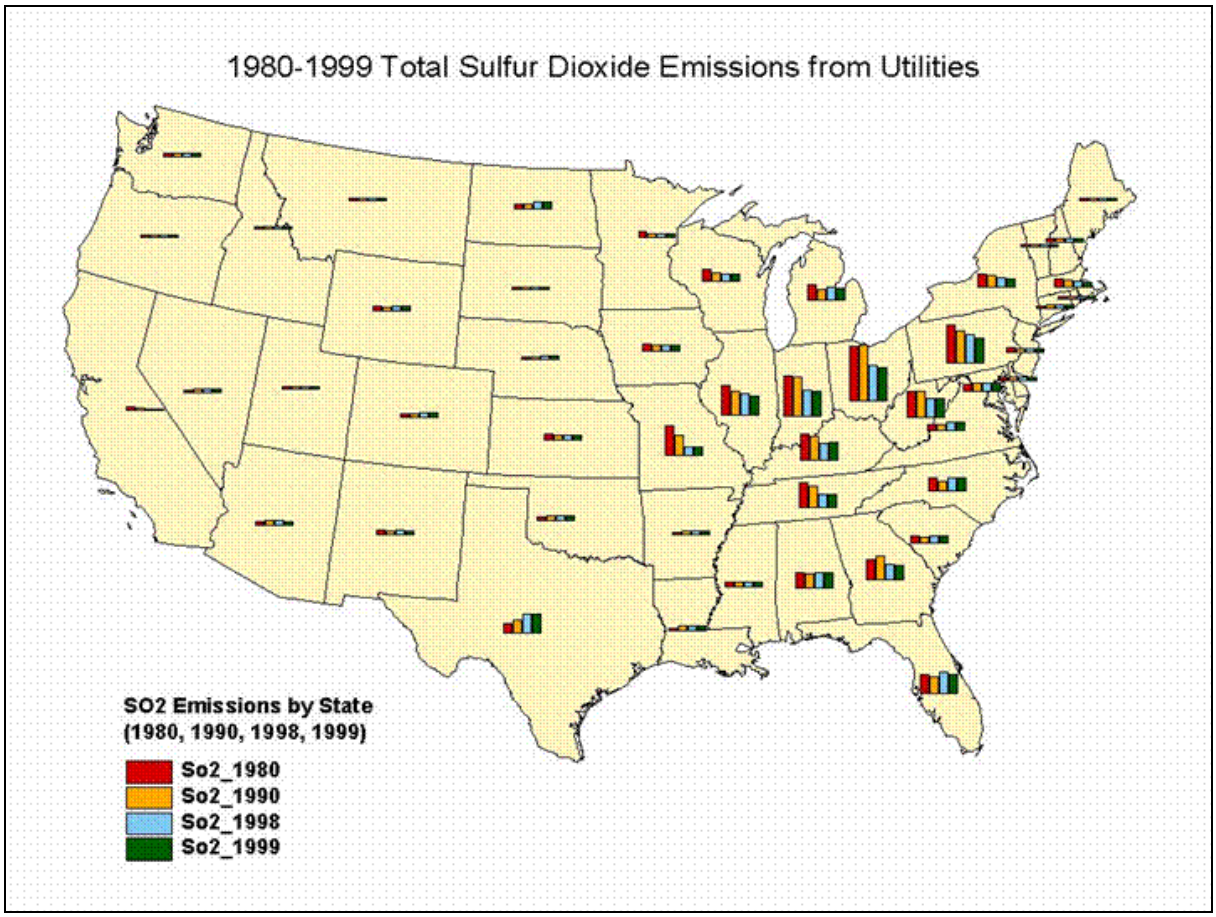
Slide 15

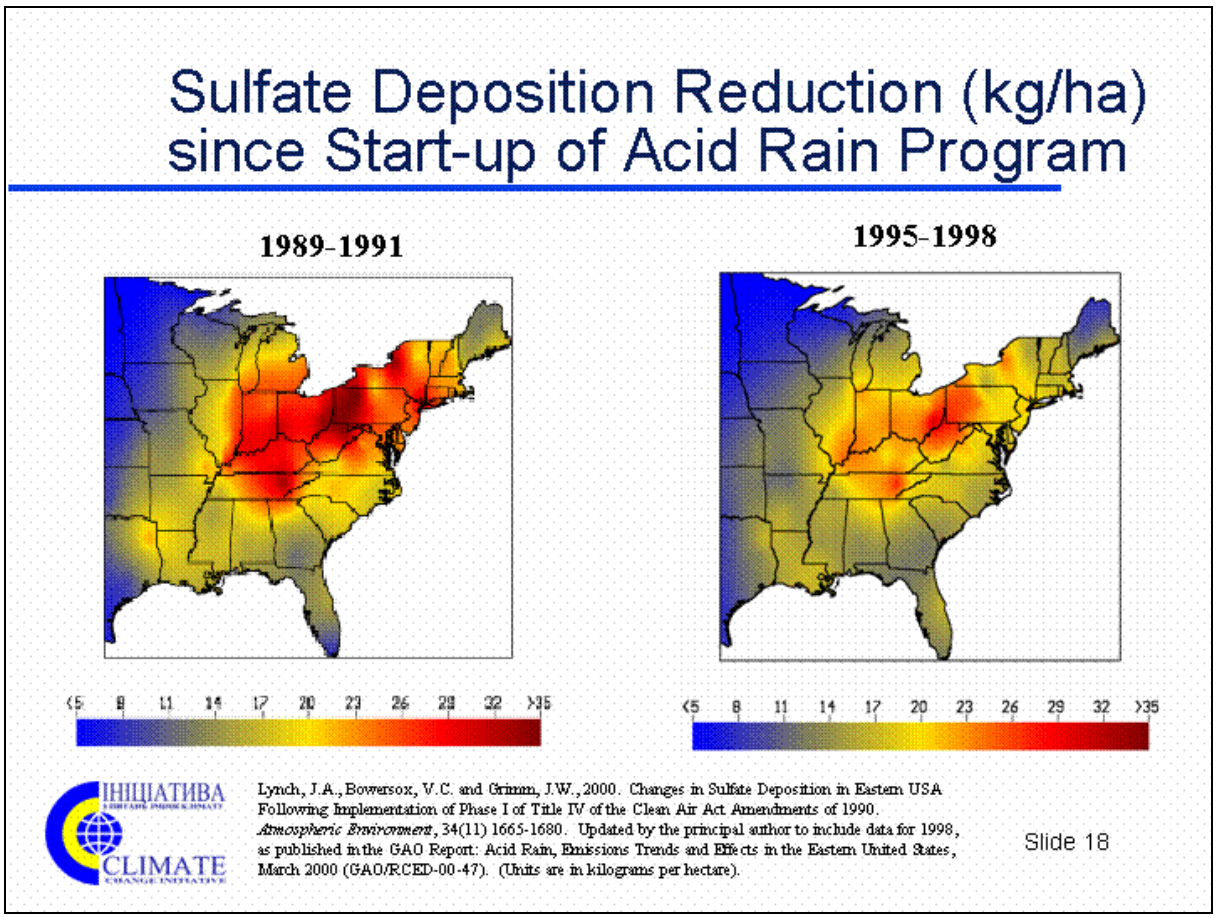
SO_2 Emissions Declined while Electricity Produced and GDP Increased



Sources: Bureau of Economic Analysis, Energy Information Administration, Acid Rain Program (EPA)

Slide 16


1980-1999 Total Sulfur Dioxide Emissions from Utilities
SO2 Emissions by State
(1980, 1990, 1998, 1999)
So2_1980
So2_1990
So2_1998
So2_1999

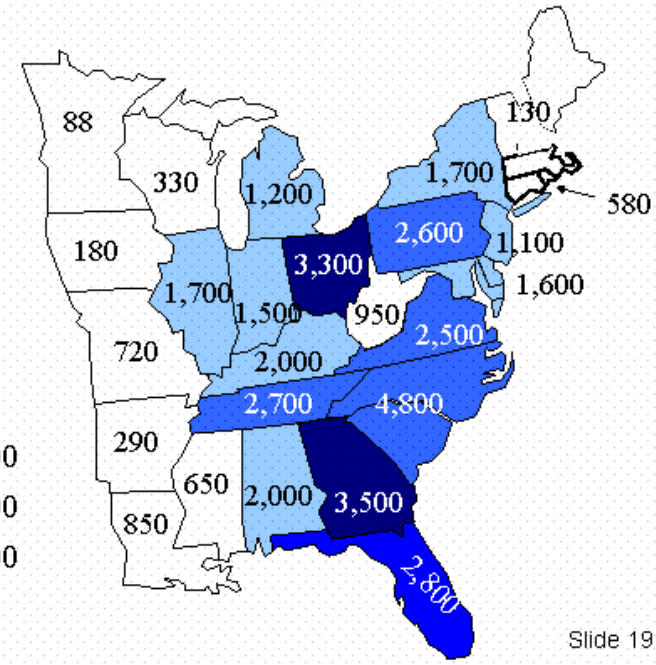

Sulfate Deposition Reduction (kg/ha)
since Start-up of Acid Rain Program
1989-1991
1995-1998
<5 8 11 14 17 20 23 26 29 32 >35
<5 8 11 14 17 20 23 26 29 32 >35
Lynch, J.A., Bowersox, V.C. and Grimm, J.W., 2000. Changes in Sulfate Deposition in Eastern USA Following Implementation of Phase I of Title IV of the Clean Air Act Amendments of 1990. Atmospheric Environment, 34(11) 1665-1680. Updated by the principal author to include data for 1998, as published in the GAO Report: Acid Rain, Emissions Trends and Effects in the Eastern United States, March 2000 (GAO/RCED-00-47). (Units are in kilograms per hectare).
Slide 18

Health Benefits of Title IV SO_2 Reductions

Estimated $40 billion in annual health benefits in 2010

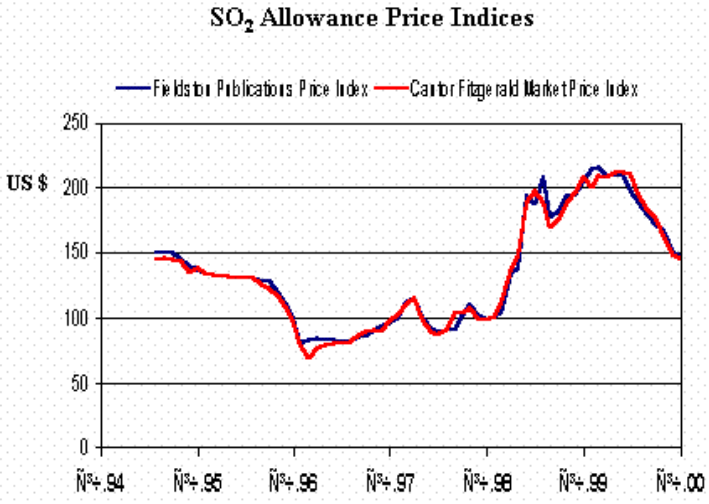
At right: Distribution of health benefits in 2010, by state (million 1994 dollars)

- $3,000-$4,000
- $2,000-$3,000
- $1,000-$2,000
- $0-$1,000



Slide 19

The SO_2 Allowance Market

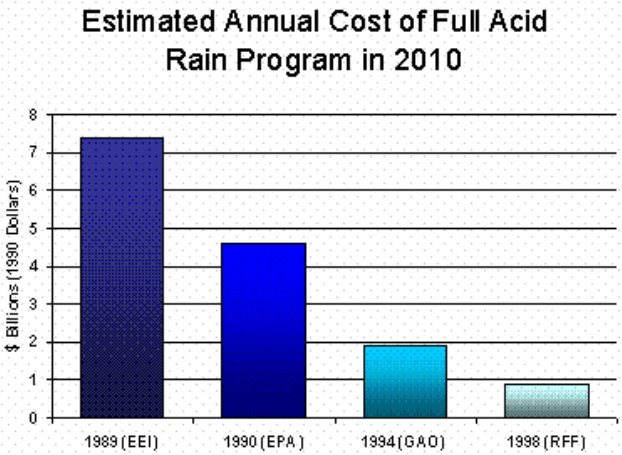


- Since 1994, over 85 million SO_2 allowances have been traded
- EPA has executed over 9,000 transactions
- Approximately 35% of all SO_2 allowances have been traded between economically distinct organizations

Source: Clean Air Markets Division

Slide 20

Expected Costs by 2010 - Less than Predicted



EEI = Edison Electric Institute (no trading)
EPA = Environmental Protection Agency
GAO = General Accounting Office
RFF = Resources for the Future

- Competition across all emission reduction options
- Markets provide continuous incentives for innovation
- Banking provides timing flexibility for emission reductions
- Markets reveal true costs

Slide 21

Keys to a Successful Cap and Trade Program

- Cap
  - Protects environment by reducing emissions & preventing increases
  - Provides predictability for the market by fixing quantity
- Accountability
  - Promotes accurate, complete and transparent emissions data
  - Predictable consequences for noncompliance
- Simplicity
  - Minimizes barriers to trade ensures efficient operation
  - Maintains low transaction costs and high volume/liquidity
  - Lowers government and industry costs
  - Provides incentives to innovate

Slide 22

Market Mechanisms Under the Kyoto Protocol for GHG Reductions

- Article 17: Emission Trading: 'Cap & Trade'
  - Emission trading among countries with targets
- Article 6: Joint Implementation
  - Two countries with targets transfer units based on investment in emission reduction project
- Article 12: Clean Development Mechanism
  - Country with target acquires units created from investing in an emission reduction project in developing country (no target)

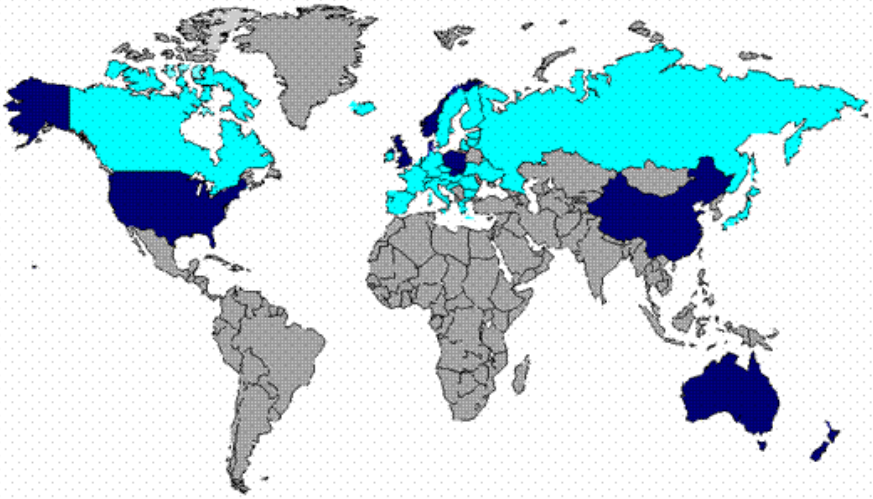
Slide 23

Cap and Trade Use Worldwide

- In 1995, the US Acid Rain Program was the only national cap and trade program for controlling air pollution in the world
- Today, cap and trade programs are being seriously considered in at least 9 countries to control domestic SO_2, NO_x, or greenhouse gas emissions
- Over 30 countries are preparing to participate in international greenhouse gas trading

Slide 24

Countries Considering Cap and Trade Programs



Countries developing or considering developing domestic cap and trade programs (SO_2, NO_x or greenhouse gases) .

Countries considering international greenhouse gas emission trading

Slide 25

Visit the Clean Air Markets Web site:

current address: www.epa.gov/acidrain

new address: www.epa.gov/airmarkets

Slide 26

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 13: Cooperative Mechanisms of the Kyoto Protocol on Climate Change: New Instruments for Environmental Protection and Technology Transfer

Overview

- **General Objectives:**

  Session 13 is an introduction to the United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the role of three "flexibility mechanisms" within the Protocol. It seeks to provide participants with an overview of the international response to the challenges of climate change, and particularly the role of each individual flexibility mechanism.

  It should address the following topics:

  - The role of the UNFCCC
  - The role of the Conference of the Parties (COP)
  - Greenhouse gases covered by the convention
  - Reduction commitments of Annex I parties
  - Joint Implementation
  - The Clean Development Mechanism
  - International Emissions Trading
  - On-going efforts of the COP

  By the end of the session, participants should have a basic understanding of the following:

  - Historical perspective on climate change actions;
  - The role of the UNFCCC and Kyoto Protocol;
  - The role of the Protocol's flexibility mechanisms;
  - Difficulties in implementing the individual flexibility mechanisms.

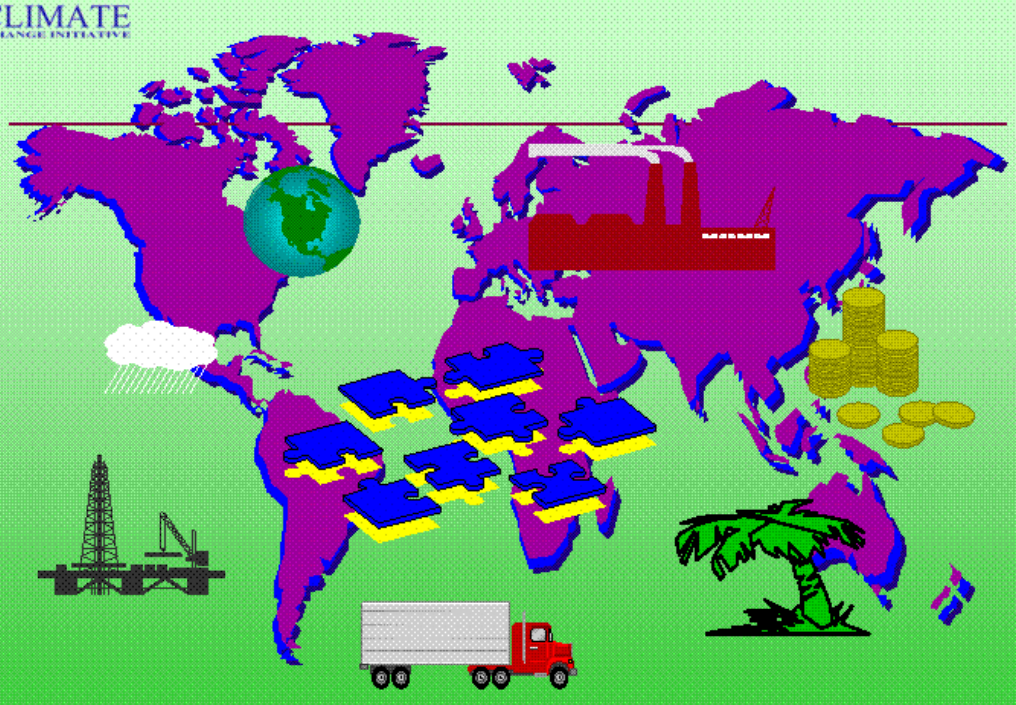
- **Activities:** Presentation, followed by period of question and answer
- **Total Time:** 60 minutes

Cooperative Mechanisms of the Kyoto Protocol on Climate Change: New Instruments for Environmental Protection and Technology Transfer

Session 13
Module 2: Economics of Climate Change

Slide 1

The Climate Puzzle



Slide 2

Market-Based Policies

- Establish Clear Environmental Goal
- Give Nations And Firms Flexibility to Compete to Achieve Environmental Goals Better, Cheaper, Faster
- Practical Experience Demonstrates:
  - Robust Compliance
  - Technology and Process Innovation
  - Reduced Cost
  - Public Accountability

Slide 3

Markets as Problem-Solving Tools

- Tap existing on-site expertise in the search for new solutions
- Create incentives for new technologies, processes, and environmental management
- Increase environmental effectiveness
- Reduce compliance costs
- Create financial rewards for total environmental performance

Slide 4

Building an Effective GHG Emissions Trading System

- *The core elements that are critical to the success of any GHG Emissions Trading System --*
  - **Limit on Total GHG Emissions (Absolute)**
  - **Measurement**
  - **Transparency**
  - **Fungibility**
  - **Consistency**
  - **Integrity**

Slide 5

Kyoto Protocol to the UNFCCC

- Signed by over 165 Nations,including all major industrialized nations
- May come into force in 2002 if enough nations ratify
- Legally binding caps on GHG emissions for industrialized ("Annex B") nations
- First commitment period: 2008-2012
- Emissions trading among Annex B nations
- Developing nations may participate
- Crediting of carbon sequestration

Slide 6

Kyoto Protocol to UNFCCC

- Four types of emissions trading
- Among nations with caps on emissions:
  - Trading in emissions allowances ("AAUs")
  - Project-based trading ("JI")
  - Redistribution of emissions budgets
- Between "Annex B" nations and others:
  - Project-based trading only (Clean Development Mechanism - CDM)
  - Reductions below what would have otherwise occurred

Slide 7

OVERVIEW OF GHG ALLOWANCE SYSTEM

- Five-year Emissions Budgets (2008-2012)
- Emissions Budget Allowances allocated to Annex B Parties
- Emissions Budgets set as percentage of Base Year (1990 or other specified pre-1990 year)
- 1 allowance - 1 ton CO_2-equivalent emissions
- Annual reporting of emissions
- At end of Budget period, each Party must hold allowances equal to emissions (Article 3)

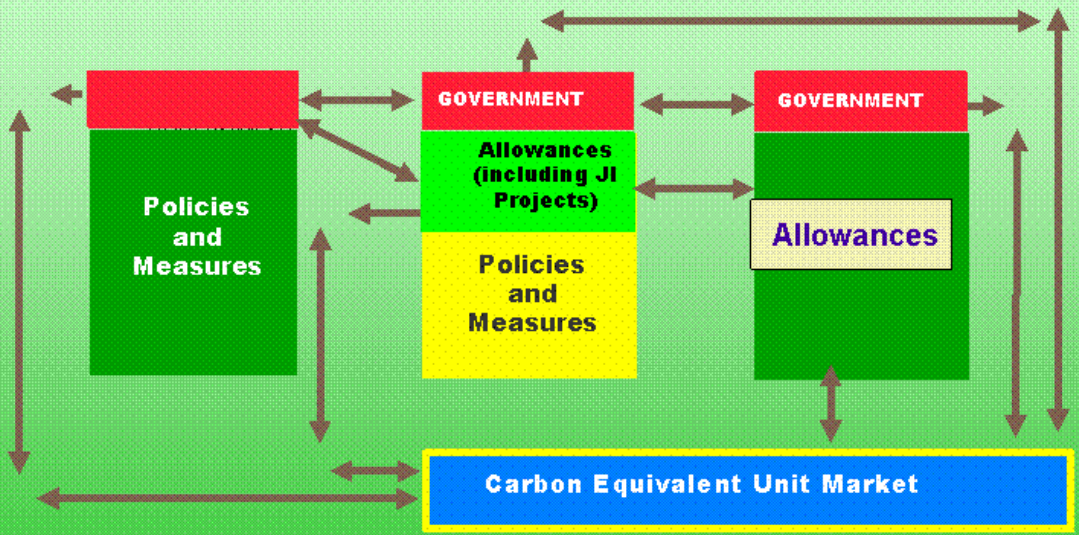
Slide 8

OVERVIEW OF GHG ALLOWANCE SYSTEM, cont'd.

- Governments will determine Marketability of Allowances
  - Internationally – Many rules set at COP-7
  - Domestically - National Programs
    - domestic allocation programs
    - allocation to joint implementation projects
    - allocation to enterprises, others who act to reduce emissions early
    - "Green Funds," revolving funds,

Slide 9

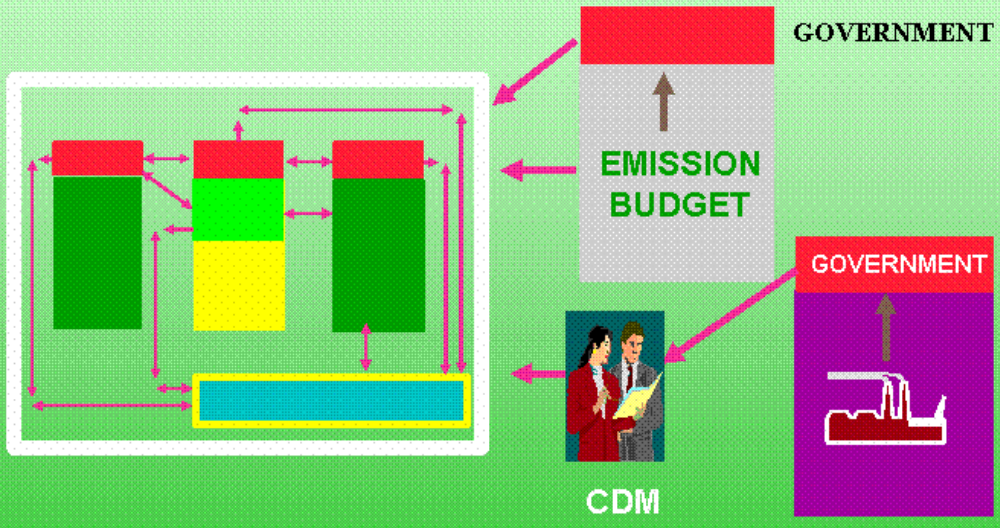
Cooperative Mechanisms of the Kyoto Protocol: Annex B Trading



Source: OECD 1996

Slide 10

Cooperative Mechanisms, cont'd. Non-Annex B Trading



Slide 11

Emissions Caps and Budgets

- Compliance = Emissions Allowances = Currency of Trading
- Regulatory Impact on All Other Choices Minimized
  - Regulator does not dictate technology choices to regulated industries
  - All compliance opportunities compete in the compliance marketplace
- Focuses Negotiators on Fundamental Points of Agreement

Slide 12

Cooperative Mechanisms: Many Rules Already In Place

- Definition of Tradable Units for Annex B Trading: AAUs, CERs, RMUs (sequestration)
  - ERUs are simply AAUs allocated to a project that are, after the project, surplus
- Quantification and Reporting Framework for Emissions, Inventories
  - Articles 3.10, 3.11, and 3.12
- Additional rules for JI to be determined by JI Supervisory Committee established at COP-7

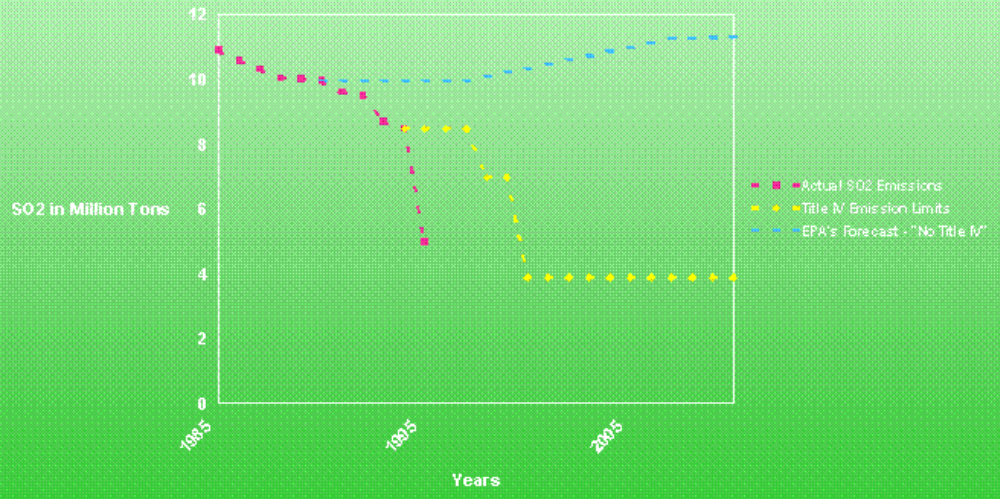
Slide 13

Cooperative Mechanisms Compared: SO2 & GHGs

- **SO2:**
  - **U.S. Sulfur Dioxide Emissions Trading Program**
  - **Controls Acid Rain**
- **GHGs**
  - **Kyoto Protocol to UNFCCC**
  - **Limits emissions of global warming gases**

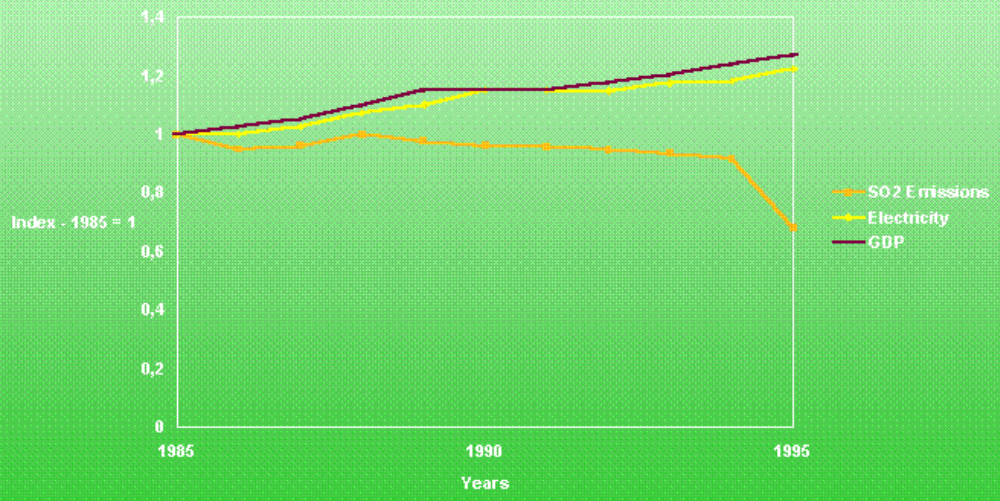
Slide 14

So2 Emissions Caps And Forecasts - Phase I Units



Slide 15

GROWTH INDICATORS AND EMISSIONS



Slide 16

SO2 & GHGs: Measurement

- SO2:
  - Continuous Emissions Monitors
  - Real-Time Reporting of Transactions
  - Annual Account Balances
- GHGs
  - Annual Emissions Reports Using "Methodologies"
  - Real-Time Reporting of Transactions (?)
  - Annual Account Balances (?)
  - Sinks Accounting?

Slide 17

SO2 & GHGs: Transparency

- SO2:
  - Emissions Transparency
  - Transactional transparency
- GHGs:
  - Emissions Transparency?
  - Transactional transparency?
  - "Concrete Ceiling" Creates Obstacle to Transparency?

Slide 18

SO2 & GHGs: Emissions Limits

- SO2:
  - Annual cap on total SO2 emissions
  - Set as multiple of historic base year
  - Two commitment phases
  - Allowances allocated to each boiler
  - Formula in statute
- GHGs:
  - Five-year cap on total GHG emissions
  - Set as multiple of 1990 or earlier year
  - 2008-2012
  - Allowances to each Annex B Party
  - Formula in Annex

Slide 19

SO2 & GHGs: Fungibility

- SO2
  - Single Pollutant
  - Full Fungibility in Well-Established National System
  - Interpollutant Transactions (NiMo-APS)
  - Transboundary, Cross-Sector Transactions?
- GHGs
  - Six GHGs; GWPs Evolving; Units: AAUs, ERUs, RMUs, CERs
  - Full Fungibility (across pollutants, sectors, borders, media (sinks)
  - Example: NiMo-Suncor

Slide 20

GHG Fungibility: The NiMo-Suncor Transaction

- NiMo-Suncor (March 1998)
  - NiMo (USA) =>Suncor (CO2 Reductions Below 1990 Levels)
  - Suncor (Canada) => NiMo (Funds to invest in further emissions reductions)
  - Amount:
    - 100,000 metric tons CO2
    - Options on 10 million tons

Slide 21

SO2 & GHGs: Consistency

- SO2:
  - Rules Established by CAAA'90 and EPA Regs
  - Rule Changes Known In Advance (Phase II)
  - Pending Legislation Could Tighten Caps
- GHGs:
  - Many Rules Established at COP7
  - Science Is Evolving
  - Will Sovereigns Resist Temptation of Arbitrary Rule Changes?

Slide 22

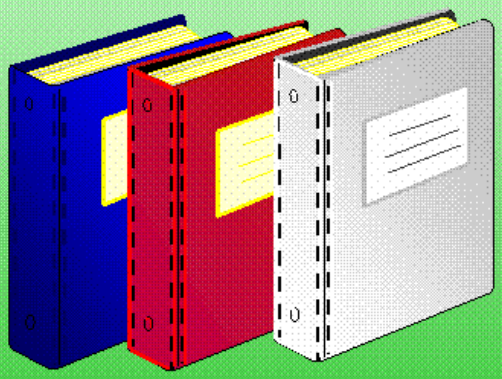
SO2 & GHGs: Integrity

- SO2:
  - Reporting & Monitoring
  - Emissions Overage
  - Sole Sovereign Imposes Stiff Financial Penalty for Both Types of Non-Compliance
- GHGs:
  - Many Sovereigns
  - Financial Penalties Environmentally Problematic
  - Automatic Consequences Needed
  - *Emissions Trading System Provides The Means!*

Slide 23

The Three Ledgers for Accounting

- Actual Emissions
- Allowances & Transactions
- Reconciliation Between Actual Emissions and Allowances-Net-of Transfers



Slide 24

The Ledgerbooks: ET and JI Compared

- The following slides illustrate hypothetical Emissions Trading (ET) and Joint Implementation (JI) transactions.
  - The slides depict only one of the "ledgers" - the transaction ledger.
  - In a real case, the actual emissions ledger and the "reconciliation" ledger also would need to be reported.

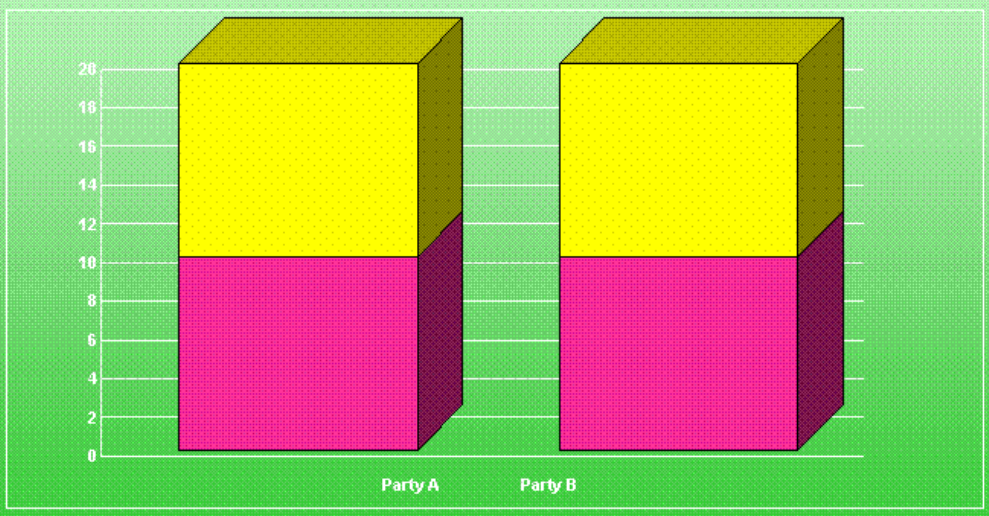
Slide 25

Emissions Trading and Joint Implementation (JI): Base Case

- Party A: Allowable Emissions of 20 Tonnes (AAUs)
- Party A's Domestic Allocation:
  - 10 Tonnes for sectors covered by Policies and Measures (PAMs)
  - 10 Tonnes for Power Sector
- Party B: Same as for Party A

Slide 26

Base Case: Party A, Party B. Each Allocates 10 Tonnes of Allowances (AAUs) to PAMs Sector, 10 Tonnes of AAUs to Power Sector



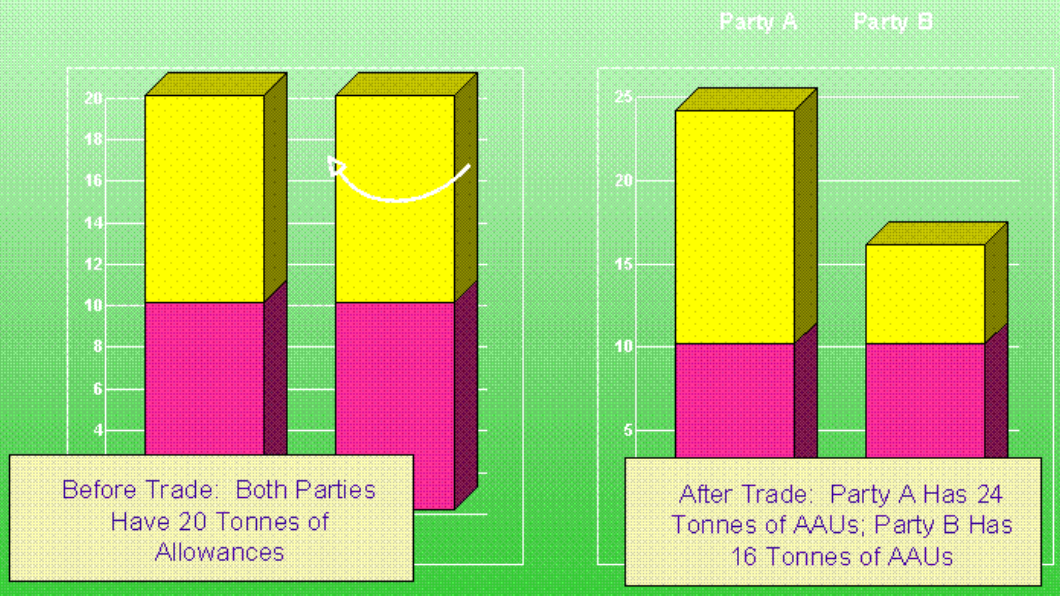
Slide 27

A Hypothetical Emissions Trade

- Party B Transfers 4 Tonnes of Power Sector Allowances (AAUs) to Party A
- In accordance with KP Articles 3.10, 3.11, Party B subtracts 4 tonnes of AAUs from its total, while Party A adds 4 tonnes to its total.
- In accordance with KP Article 3.1, Party A may emit 24 tonnes, while Party B may only emit 16 tonnes.
- Registers of tonne-accounts must be reconciled with registers of actual emissions (not shown).

Slide 28

A Hypothetical Emissions Trade: Party B Transfers 4 Tonnes of Power Sector Allowances (AAUs) to Party A (See Articles 3.10, 3.11)

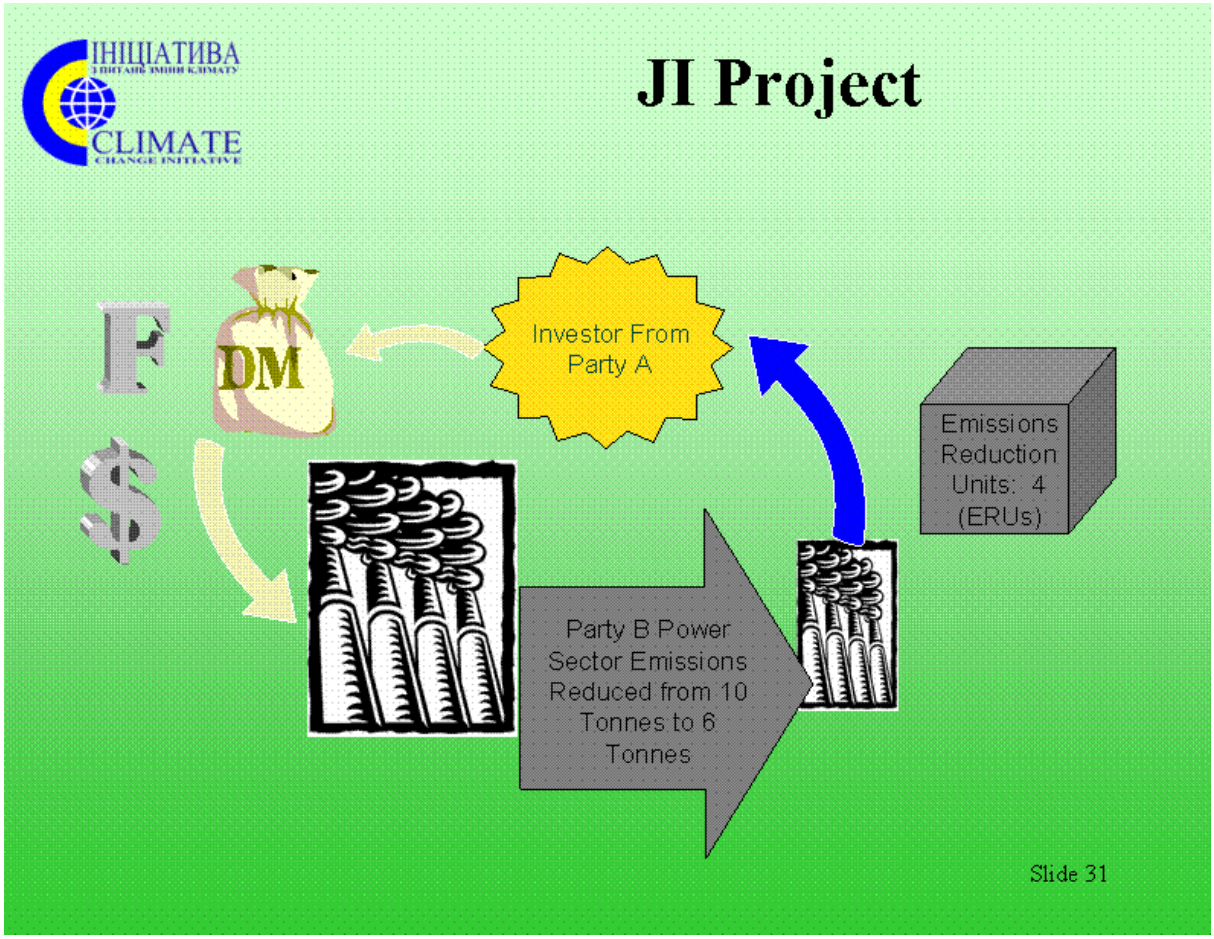


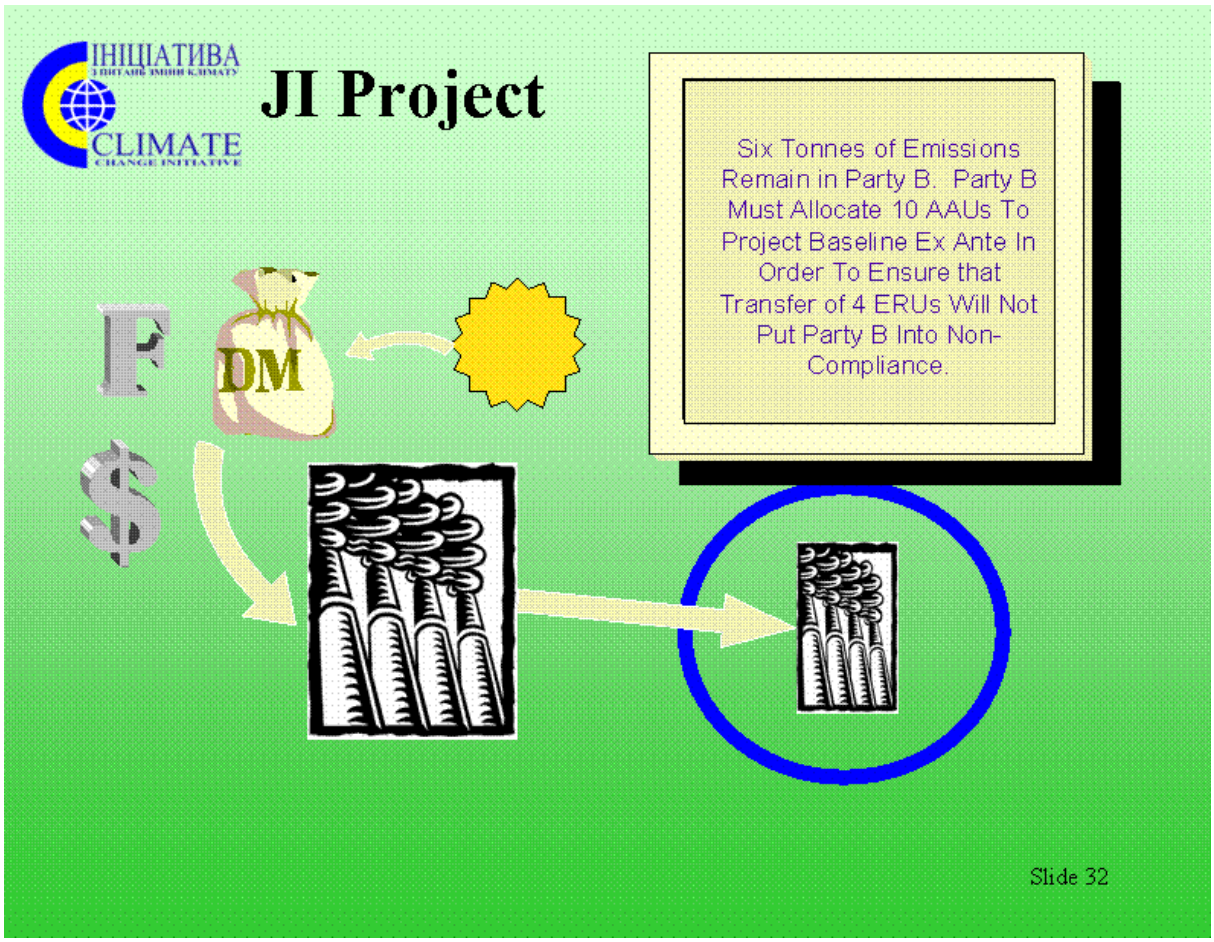
Slide 29

A Hypothetical JI Project

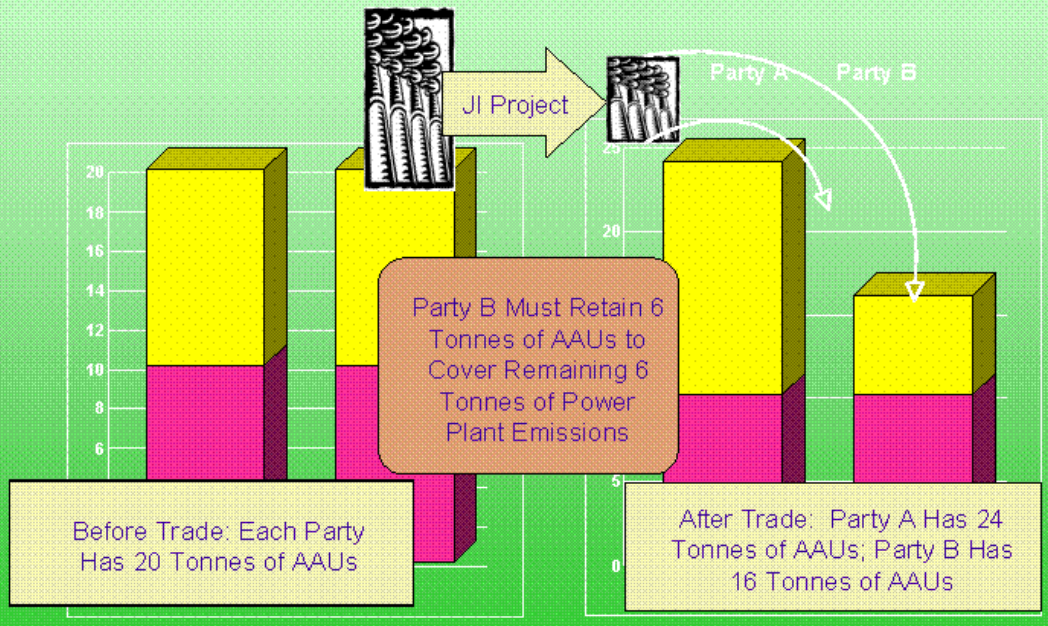
- Investor in Party A invests in power sector project to reduce Party B emissions from 10 tonnes (baseline) to 6 tonnes.
- The investor seeks to transfer 4 tonnes of ERUs.
- If project actually reduces emissions to 6 tonnes, the 4 tonnes may be transferred.
- Post transfer, power sector will still emit 6 tonnes.
- To ensure compliance, Party B must retain 6 tonnes AAUs to "cover" power sector emissions.
- To ensure that ERUs are truly surplus, Party B must allocate 10 tonnes of AAUs (baseline) to the project *at the outset*.

Slide 30


JI Project
F
DM
$
Investor From Party A
Emissions Reduction Units: 4 (ERUs)
Party B Power Sector Emissions Reduced from 10 Tonnes to 6 Tonnes
Slide 31


JI Project
F
DM
$
Six Tonnes of Emissions Remain in Party B. Party B Must Allocate 10 AAUs To Project Baseline Ex Ante In Order To Ensure that Transfer of 4 ERUs Will Not Put Party B Into Non-Compliance.
Slide 32

JI Project Accounting: Investments Reduce Party B's Power Sector Emissions From 10 to 6 Tonnes; Party B Transfers 4 Tonnes of Surplus Allowances (ERUs) to Party A; Party B Retains 6 Tonnes of AAUs to Cover Remaining Power Plant Emissions



Slide 33

JI Project Accounting: Failure To Do Ex Ante Allocation of Baseline

- Suppose a Party fails to make ex ante allocations of JI project baselines.
- Suppose ten projects emit 10 tonnes each as baseline; each project will reduce by 4 tonnes.
- If Party transfers 40 ERUs, but fails to retain 60 AAUs to cover remaining project emissions, Party's actual emissions may exceed AAUs net-of-transfers, and Party will be in non-compliance.

Slide 34

The Ledgerbooks: Lessons for Compliance

- The Fundamental Challenge of International Legal Instruments For Curbing Climate Change is to *Create Incentives for Sovereign Nations To Comply With Emissions Limitations*
  - Kyoto Protocol Mechanisms Provide Built-In Incentives for Sovereign Compliance
  - Further Mechanisms Established at COP-7 To Discourage Emissions In Excess Of Assigned Amounts

Slide 35

Compliance Incentives Needed For All Parties

- Verification and Compliance Incentives Provide Accountability For All Parties:
  - Parties Operating Solely Under Article 3
  - Parties Transferring AAUs Under Art. 17
  - Parties Transferring AAUs Under Art. 6
  - Parties Receiving And Transferring CERS under Art. 12
  - Parties Reallocating AAUs Under Art. 4

Slide 36

Accounting Rules For Compliance: Key Principles

- The Primary Measure of Kyoto Protocol Compliance:
  - At End of Commitment Period, Are Actual Net Emissions less than or equal to Adusted Assigned Amount?
  - Basic Accounting Rules: Art.s 3.10-3.12
  - If At End of Commitment Period, A Party's Actual Emissions Exceed Adj. Assigned Amount, *The Party Is In Non-Compliance*
  - Also, If A Party Fails To Report Actual Emissions, *The Party Is In Non-Compliance*

Slide 37

Accountability Rules Adopted at COP-7:

- If a Party fails to meet its emissions target:
  - It must restore the "deficit" emissions at a ration of 1.3 to 1 during the next commitment period.
  - The Party cannot use the cooperative mechanisms
  - The Party must submit a "compliance action plan".

Slide 38

Key Issue Unresolved at COP-7

- Are consequence for non-compliance "legally binding" (as a matter of international law) or merely "politically binding"?
- This issue delayed to first COP to take place after the Kyoto Protocol comes into force

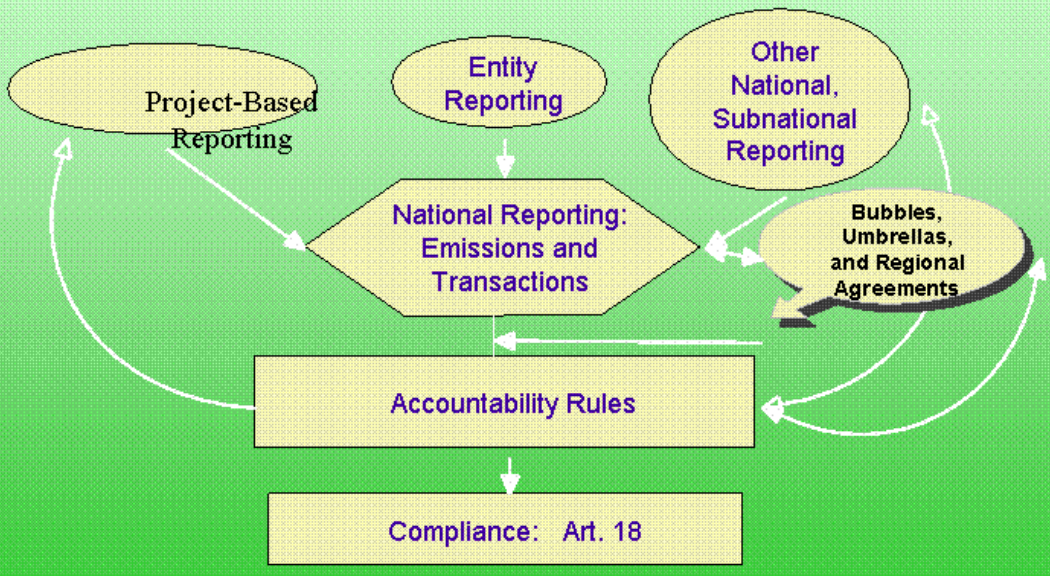
Slide 39

International Institutions

- **National Registries**
  - **Emissions**
  - **Allowances**
- **Nomination of Competent Government Authority**
- **Publication of National Report**
  - **Emissions and Allowances**
- **The Accounting Entity**
- **The Compliance Entity**

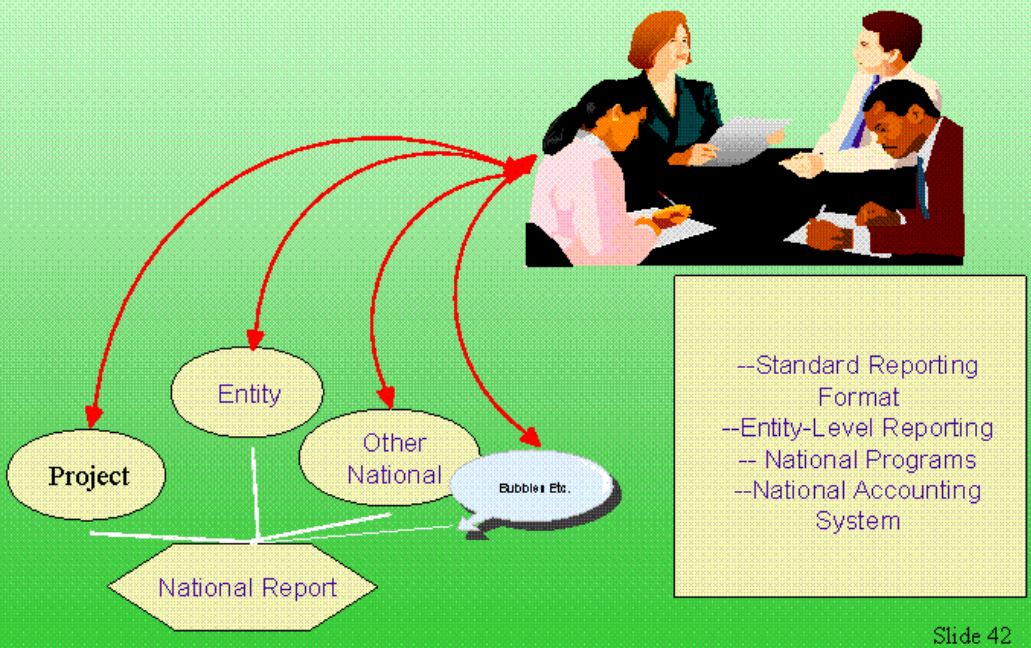
Slide 40

Steps in the Process: Reporting, Accountability and Compliance:

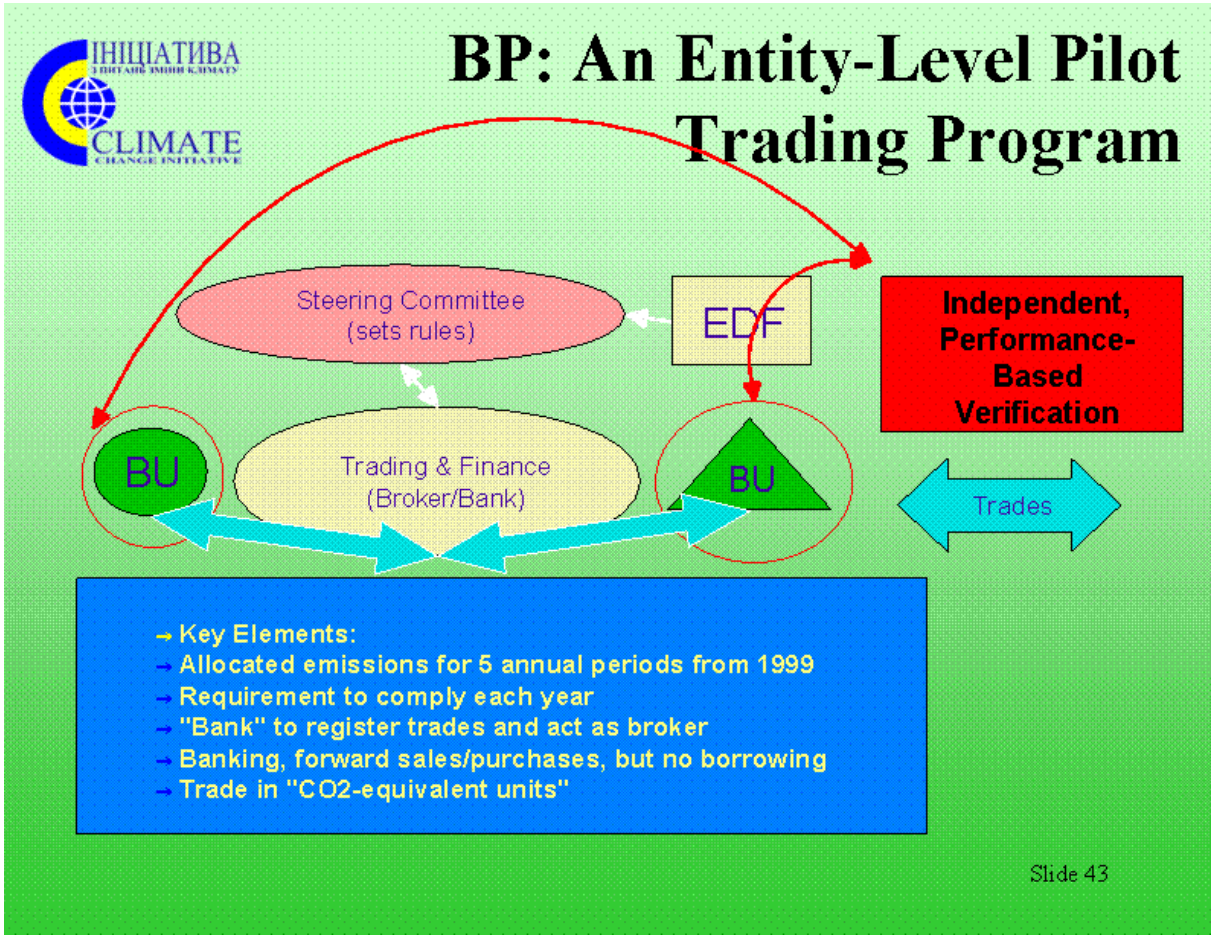


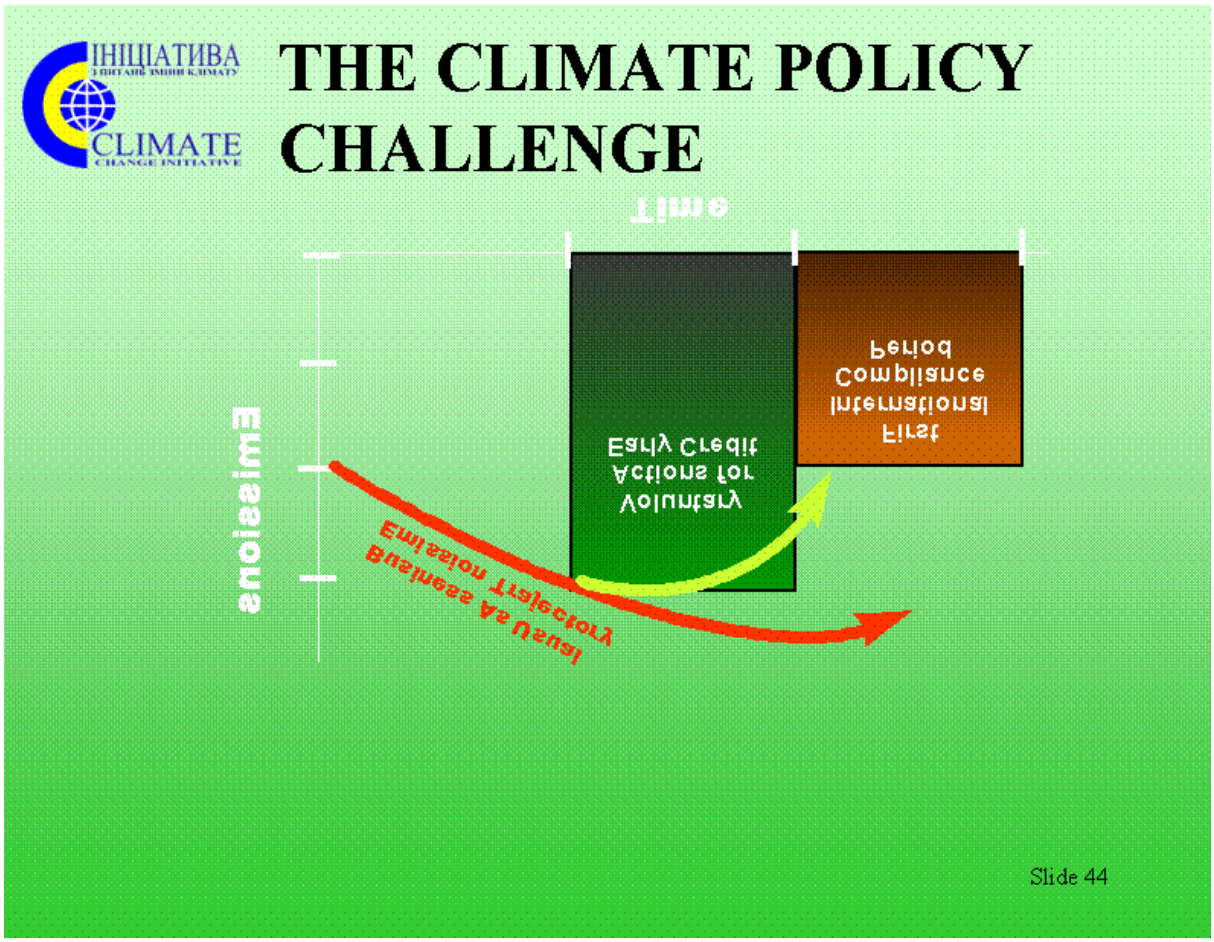
Slide 41

Steps in the Process: Verification

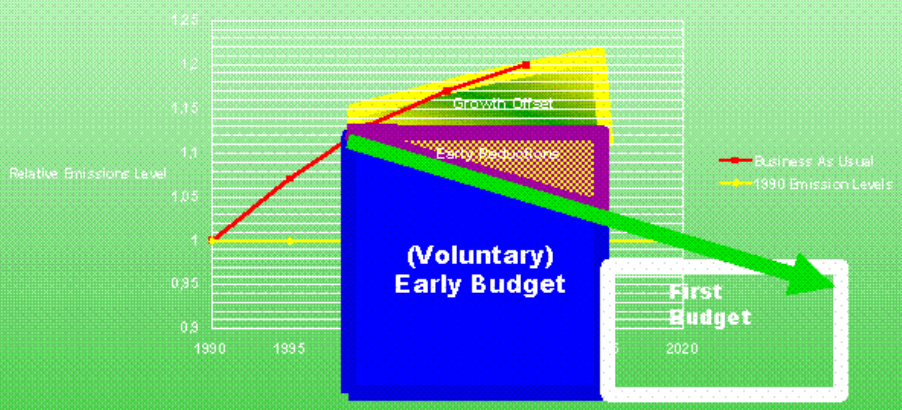


Slide 42


BP: An Entity-Level Pilot Trading Program
Steering Committee (sets rules)
EDF
Independent, Performance-Based Verification
BU
Trading & Finance (Broker/Bank)
BU
Trades
→ Key Elements:
→ Allocated emissions for 5 annual periods from 1999
→ Requirement to comply each year
→ "Bank" to register trades and act as broker
→ Banking, forward sales/purchases, but no borrowing
→ Trade in "CO2-equivalent units"
Slide 43


THE CLIMATE POLICY CHALLENGE
Time
Emissions
Early Credit Actions for Voluntary
First Compliance International Period
Business As Usual Trajectory
Emission Reduction
Slide 44

Early Allocation For Early Actions



Source: EDF

Slide 45

Learning-By-Doing

- Novgorod Project: Technical Issues
- Investment Facility
- Legal and Institutional Issues
- Compliance Reserve
- Forward Sales

Slide 46

Conclusion: Cooperative Mechanisms

- Cooperative Mechanisms have potential to improve environmental performance, spur technology transfer, address economics
- Minimum elements need work!
  - transparent institutions
  - maximize competition in favor of environmental performance and reduced cost

Slide 47

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 14: Key Points for JI Projects

Overview

General Objectives: Session 14 is intended to give an overview of the various criteria that are involved is establishing a JI project. The session will describe key criteria that investors will scrutinize at the project identification stage, and will review concepts that have been addressed in other training modules (e.g., baselines, MERVC). This session will also include a discussion of national issues/aspects that influence the review of JI project proposals. By the end of the session, participants should have a basic understanding of:

- The various approaches using in defining project baselines
- The various issues relating to the notion of "additionally"
- The central role of MERVC (Monitoring, Evaluation, Reporting, Verification, and Certification) guidelines
- The various issues relating to the notion of “supplementary” and the GHG credits market
- Compliance and liability in GHG credit trades

Activities: Presentation, followed by period of questions and answers

Total Time: 60 minutes

Materials: Set of 26 OHTs

Key Points for JI Projects

Session 14

Module 2: Economics of Climate Change

1

Outline of the Presentation

- Approaches to defining project baselines.
- Issues relating to additionality.
- Monitoring, Evaluation, Reporting, Verification, and Certification (MERVC) guidelines
- "Supplementarity" and the GHG Credits Market
- Compliance and liability in GHG credit trades

2

Defining Project Baselines

- Who has the responsibility for defining the baseline?
  - The ultimate responsibility must be with the host country.
  - The actual responsibility will fall to the project developer / investor.
  - Validation and certification will discourage inflating of baselines.
- What factors should be considered in defining the baseline?
  - Current trends in technology and practice.
  - Financial optimums.
  - Economic optimums.
  - Projections / simulations of future expectations.
- When should the baseline be defined?
  - During project preparation and design
  - Possibly in advance to attract JI investments.

3

Baseline Methods under Consideration

- **Project-specific** vs. **multi-project** (benchmarks)
- Standardized vs. ad hoc;
- **Static** vs. **dynamic**
- Stringency, technology matrices, exclusions, etc.
- Financial and other "additionality tests"
- Methods must be: **credible**, **transparent**, and **practical** and balance between
  - **environmental integrity** (minimize free riders and unwarranted credits, opportunities for gaming)
  - **investor incentive** (low transaction cost, maximum reasonable credits)

4

Steps for Defining the Project Baseline

1) Establish clear project boundaries that are the same for the baseline as they are for the JI project.

2) Clearly define the proposed JI project and identify the "normal" economic benefits/outputs of the project (e.g., kWh, lumens, tons of steam, passenger kilometers, etc.).

3) Define the baseline project that will result in similar economic benefits/outputs.

4) Ensure that the "normal" economic benefits / outputs of both the JI project and Baseline project are equal so that we are not comparing "apples against oranges".

5

Project Baseline Issues

Measurability of baseline GHG emissions – the baseline project is counterfactual and does not exist if the JI project is selected. Thus the emission profile of the baseline project is hypothetical. However, the emission profile of similar baseline projects may be substituted.

Changes in expected baseline project emissions may occur due to political, economic, technical and institutional uncertainties. Dealing with these uncertainties in the baseline definition phase is not practical. They should be evaluated during the verification processes for emissions from JI projects.

Validity period for baseline emissions – the period for which baseline emissions are valid should be equivalent to the period for which the baseline project is in fact replaced by the JI project. However, it should not exceed the economic life of the baseline project.

6

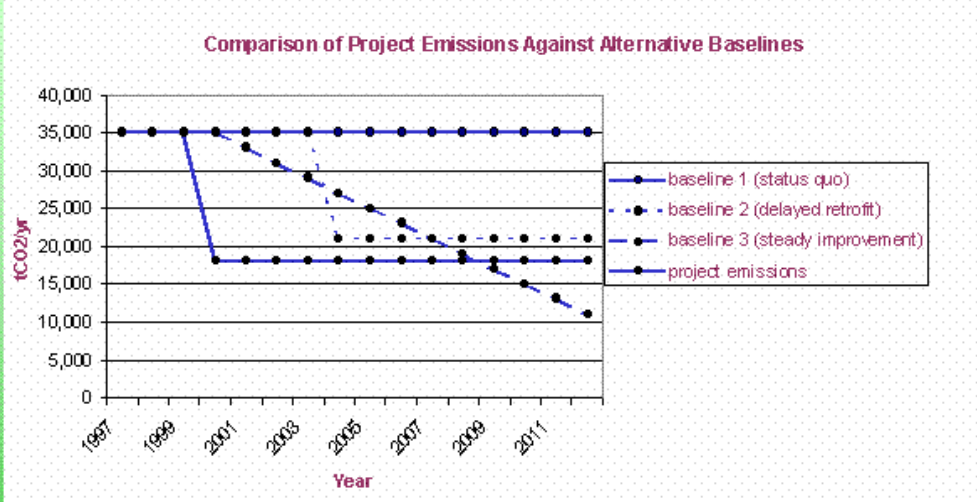
Project Baselines: Example

JI Project: Energy efficiency retrofit at a manufacturing plant :

- Baseline 1: Status quo situation (no change expected at plant)
- Baseline 2: Future improvement expected at plant (retrofit anticipated, but at later date -- say, 2005)
- Baseline 3: Sector-wide improvement expected (steady improvement in sector efficiency)

7

Project Baselines: Example



	Baseline 1	*Baseline 2*	*Baseline 3*	*Project Emissions*
cumulative emissions	455,000	329,000	299,000	234,000
total credit	221,000	95,000	65,000	-

8

Recommendations for Project Baselines

- The process for defining project baselines should be simple and transparent.
- Project baselines may be preferable to national or sectoral baselines, technology matrices or benchmarks as they provide a direct means of assessing the additionality of proposed projects.
- Project baselines should provide sufficient information to allow for the determination of both emissions reduction and financial additionality.
- The period of validity of project baselines should be of sufficient length to minimize uncertainty for project investments.

9

Possible "Additionality" Criteria

- **Environmental "additionality"** - emissions reduction in addition to any that would occur in the absence of the JI project.
- **Financial and economic "additionality"** - Present value of all financial and economic capital and O&M costs for the JI project is greater than the baseline. *Should no-regrets options qualify under the JI mechanism?*
- **Additional development assistance resource** - financial resources in addition to ODA, GEF, and other development assistance.
- **Technology "additionality"** - would all project types (*i.e., nuclear power, fossil fuels*) qualify as JI projects.
- **Stringent baseline** - to prevent rewarding inefficient policies

10

MERVC

Monitoring, evaluation, reporting, verification, and certification:

- **Monitoring**: measurement of the technical and environmental performance of the project (i.e., energy produced, GHG emissions, etc.)
- **Evaluation**: analysis of project performance data to determine project environmental and economic benefits (i.e., GHG emissions reduction, cost of per tone of carbon, etc.)
- **Reporting**: formal presentation of project performance and analyzed results. May be presented periodically during project implementation.
- Monitoring, evaluation, and reporting are likely performed by project implementers.

11

MERVC (*cont.*)

Monitoring, evaluation, reporting, verification, and certification:

- **Verification**: independent periodic auditing of the reported project performance and claimed emissions reduction against validated baseline.
- **Certification**: formal endorsement of the verified project results. Certifier may be liable for emissions reduction credits it certifies.
- Verification and certification will need to be performed by a third party.
- MERVC process needs to be credible, simple, transparent, and cost-effective.

12

Issues in MERVC

- Agreement on the MERVC process
- Access to information and data on baselines and project performance (e.g., emissions and other project data)
  - Proprietary data
  - Baseline leakage
- Certification of independent agencies and third party verifiers.
- Technical capacity to carry out MERVC
- Possible high transaction cost
- Non-conformance cases

13

"Supplementarity" Criteria

Article 6, Joint Implementation Mechanism

*"The acquisition of emission reduction units shall be **supplemental** to domestic actions for the purposes of meeting commitments… "*

Early proposals to quantify this "supplementarity" were ultimately rejected in the rules adopted at COP-7.

14

Estimates of Demand for GHG Credits

- Most of the OECD-Annex B countries are unlikely to meet their first commitments (2008-2012) of the Kyoto Protocol.
- A number of studies estimated that the baseline scenario for these countries will exceed their commitments:
  - North America by 21% to 30%
  - Pacific OECD by 19% to 29%
  - Western Europe by 16% to 27%
- Globally, the demand for GHG credits was estimated at
  - Low of 621 MtC/yr in 2010
  - High of 1,300 MtC/yr in 2010
- *These estimates (and those in the slides that follow)are illustrative and assumed that the U.S. would participate in the Protocol*

15

Estimated Demand for GHG Credits

Source:	Estimated Demand in 2010 for GHG Credits (MtC/yr)
EPPA	1312
Haites	985-1000
G-Cubed	1102
GREEN	1298
SGM	1053
Vrolijk	669
Austin, et al.	1200-1300
Zhang	621
Ellerman, et al.	328-1049
US Administration	750

Sources: Zhang (1999), Edmonds et al. (1998); Ellerman et al. (1999); Vrolijk (1999); Haites (1998).

16

Estimated Domestic Marginal Abatement Cost for Deficit Annex B Parties

Source	Cost / Ton C
Massachusetts Institute of Technology (September 1998)	$ 584 (Japan) $ 186 (USA) $ 273 (European Union) $ 233 (other OECD countries)
Pacific Northwest National Laboratory (Oct. 98)	$350 (Canada) $458 (Japan) $168 (U.S.) $130 (W. Europe) $117 (Australia)
Zhang (1999)	$9.1 (EU) $312 (Japan) $160 (U.S.) $33 (Other OECD)
US EIA (Oct. 98)	$67-$348
CRA (June 1998)	$295

17

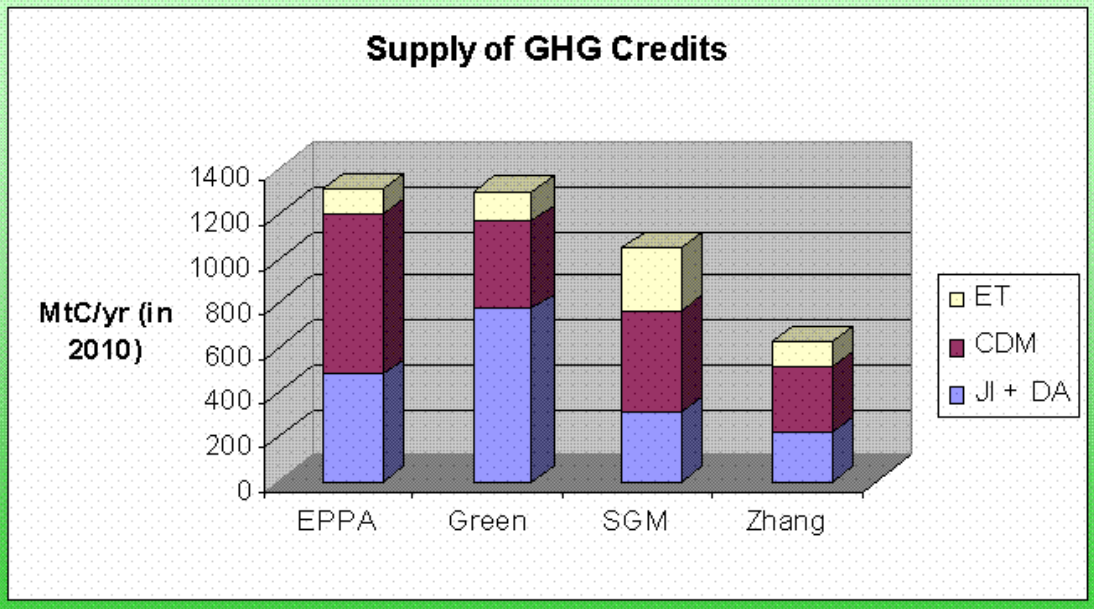
Estimates of the Supply of GHG Credits

Source	JI + DA	CDM	ET	Total
EPPA	478	723	111	1312
Green	771	397	130	1298
SGM	310	454	289	1053
Zhang	224	292	105	621
IEA	NA	NA	156	NA
EIA	NA	NA	374	NA
Haites	NA	265-575	NA	NA

DA=Domestic Actions;
Source: Derived from Data in Zhang (!999)

18

Estimates of Supply of GHG Credits



19

Estimated International Price for GHG Credits

Source	Assumptions	Price (US$/tC)
MIT	Global Trading-no limits	$24
PNNL	Global Trading-no limits	$26
US CEA	Global Trading-no limits	$14-$23
Charles River Assoc	Global Trading-no limits	$50
Zhang	Global Trading-no limits Limited demand –50% from Annex I Limited demand –EU proposed ceilings Limited supply– no hot air traded	$9.6 $4.7 $3.5 $12.6

- The MAC for GHG credits from ET = $0/tC

20

Supply and Demand Uncertainties

- There is a wide variation in the estimates of demand, supply and price (marginal abatement costs) data for GHG credits.
- The variation derives from uncertainties in:
  - projected growth in GHGs to 2012;
  - MAC of domestic actions;
  - the level of domestic actions required;
  - the rules for the flexibility mechanisms; and
  - MAC for JI and CDM projects.
- The uncertainty is spawning a lot of speculation.

21

Risk Factors Affecting GHG Credit Prices

- Assurance of host government to transfer of credits - host government guarantee;
- Validation of project and baseline by host government;
- Ability to monitor and verify credits;
- Project output market risks;
- Technology/project operation risks;
- Risks associated with the project owner;
- Financial soundness of the buyer; and
- Political and other risks.

22

Issues in Compliance and Liability

- Who is responsible for traded allowances if selling Party is not in compliance with it's target?
- Parties participating in trading must have strong inventory monitoring system in place.
- Eligibility requirements might help ensure that trading party:
  - meets standards for emissions data quality
  - has comprehensive and transparent inventory system
  - fulfils reporting requirements
  - has adopted and enforced compliance regime
  - has established a "compliance reserve"

23

Compliance and Liability (*cont.*)

- **"Seller-beware" (seller liable)**
  - seller takes risk that it has oversold allowances
  - buyer is assured that allowances are valid
- Makes allowances fully fungible, market more straightforward
- May provide insufficient safeguards against non-compliance
- **"Buyer-beware"**
  - if seller is non-compliant, traded allowances are invalid
  - buyer has purchased allowances that might be useless
  - proportionate vs. vintage approach (most recent sales by non-complier are liable)
- Provides disincentive to purchase from potential non-compliers
- May diminish value of allowances

24

Protecting Against "Overselling"

- To protect against the risk of Parties overselling credits, COP-7 requires that each Annex B retain a "commitment period reserve" of at least 90% of its assigned amount of allowable reductions
- Parties falling below this amount will not be able to sell credits any longer, but will be be able to buy in order to meet the reserve level, and thus be able to sell again.

25

Arguments for Flexibility Mechanisms

- Lower cost of compliance with targets (allows negotiation of lower targets)
- Mobilize private capital for GHG mitigation
- Facilitate technology transfer and foreign investment
- Echoes prevailing belief in benefits of free trade and trade liberalization
- Consistent with the prominent roles of transnational actors

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MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 15: Introduction to Monitoring, Evaluation, Reporting, Verification and Certification (MERVC) issues

Overview

General Objectives: Session 15 is intended to give a broad overview of additional procedures for GHG emission reduction projects: estimation and registration, monitoring, evaluation, reporting, verification and certification of GHG reductions (MERVC). They envisage estimation and registration at the project development stage, reporting – at all project stages, all other procedures – during project implementation. This session includes main definitions of key concepts of these procedures and main requirements for their use.

By the end of the session, participants should have a basic understanding of:

- Range of issues that need to be addressed in development and implementation of emission reduction project,
- The key definitions of estimation and registration, monitoring, evaluation, reporting, verification and certification of GHG reductions,
- How MERVC procedures should be applied during development and implementation of joint implementation projects.

Activities: Presentation, followed by period of questions and answers.

Total Time: 30 minutes.

Materials: Set of 15 OHTs.

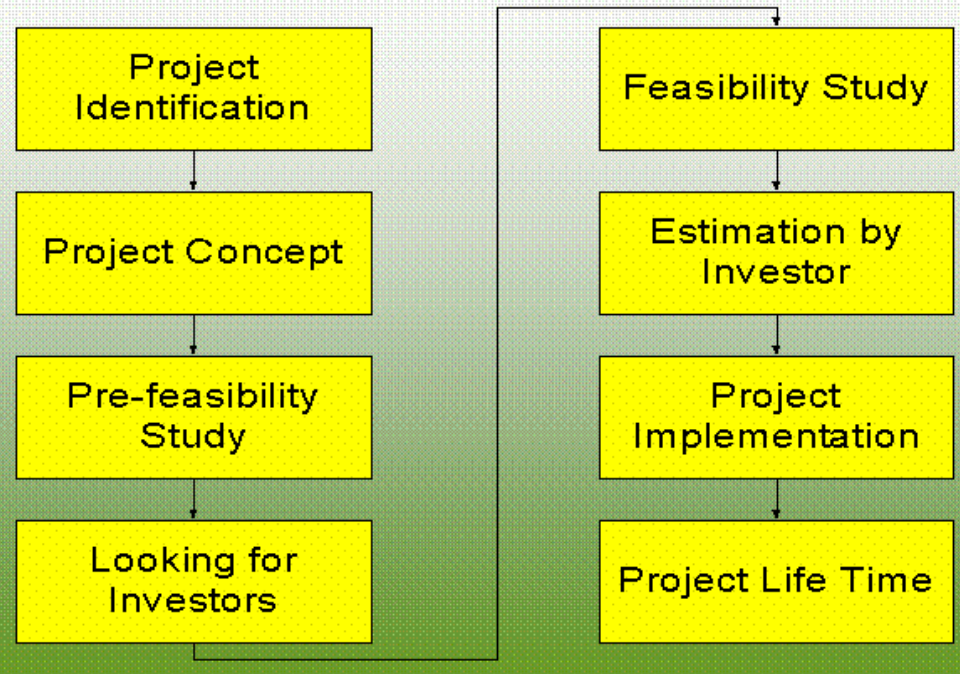
Introduction to Monitoring, Evaluation, Reporting, Verification and Certification (MERVC) issues

Session 15

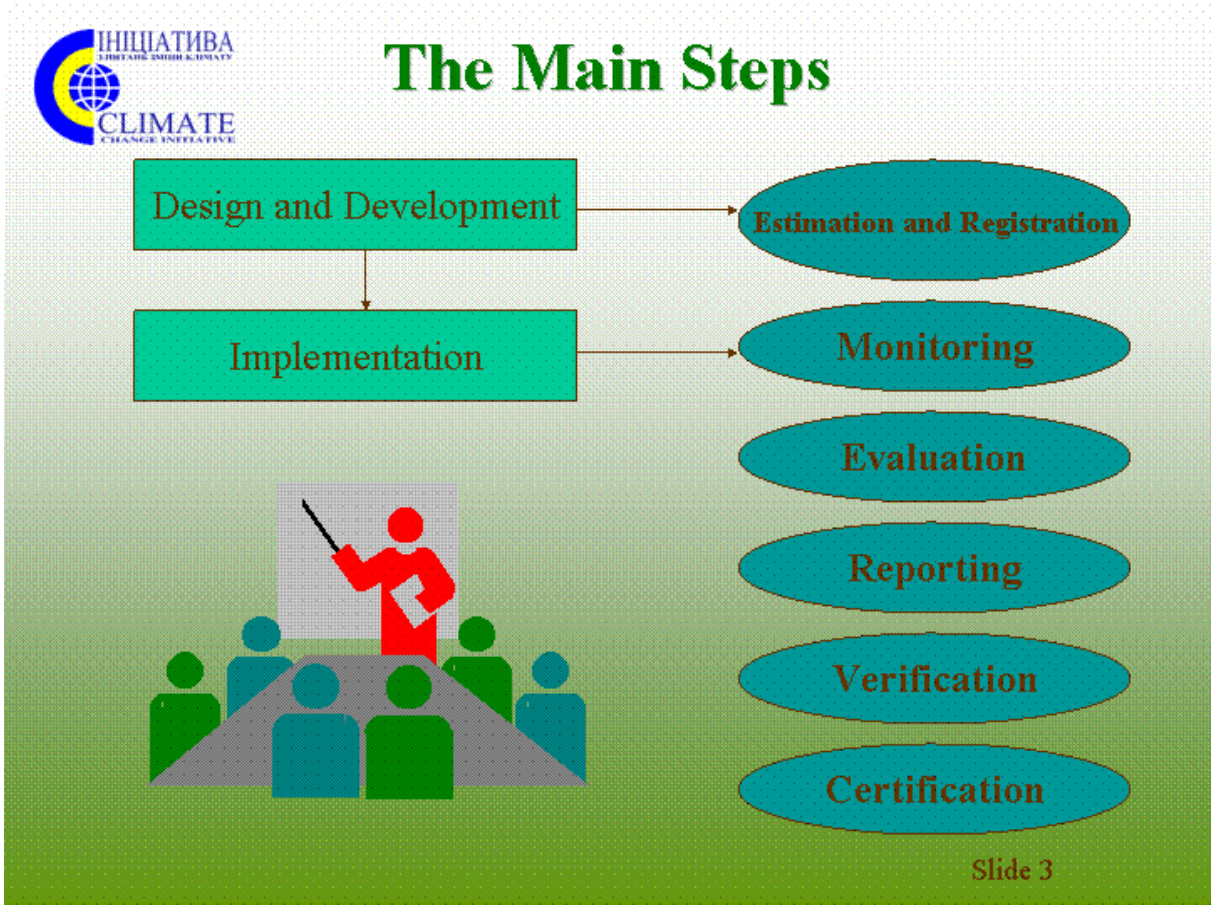
Module 2: Economics of Climate Change

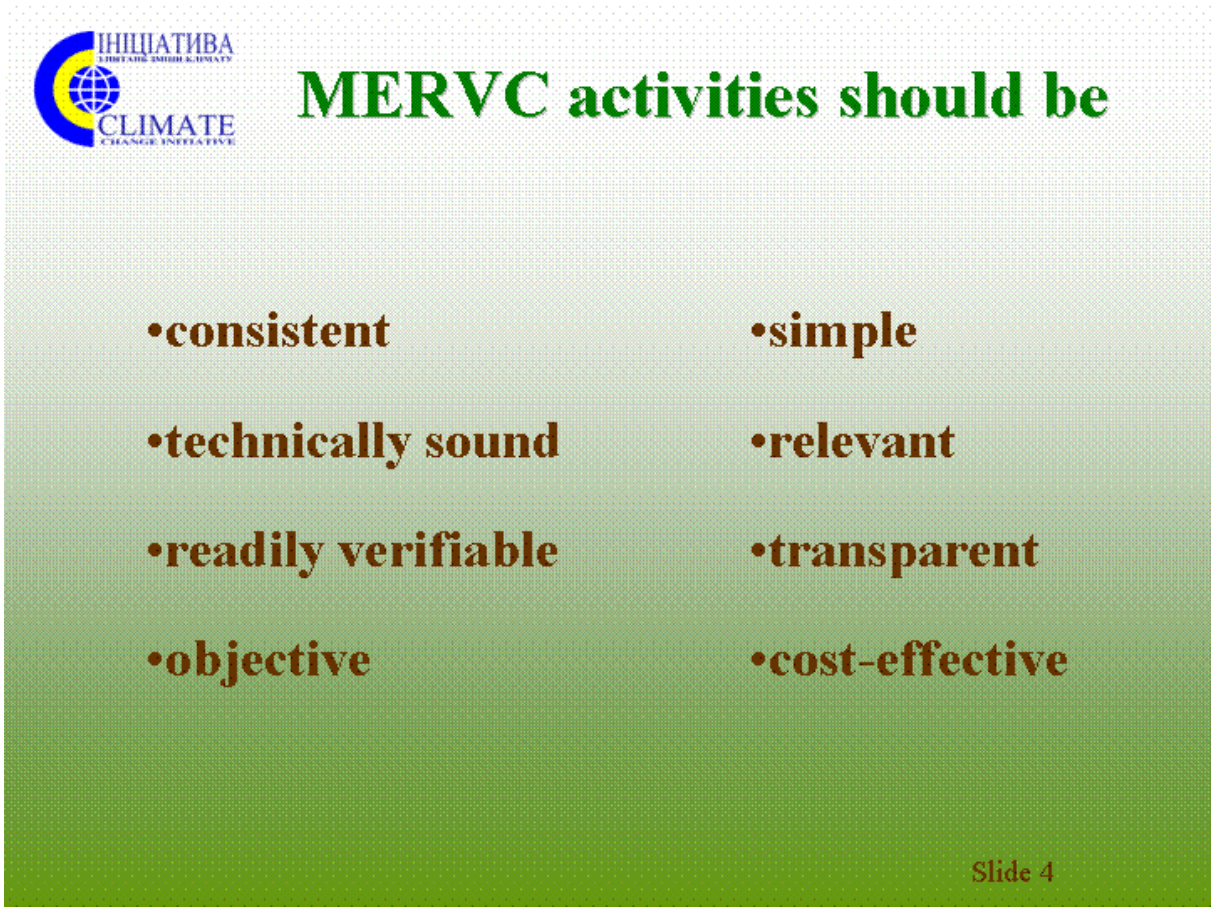
Slide 1

The Main Steps of Investment Project



Slide 2


The Main Steps
Design and Development
Implementation
Estimation and Registration
Monitoring
Evaluation
Reporting
Verification
Certification
Slide 3


MERVC activities should be
•consistent
•simple
•technically sound
•relevant
•readily verifiable
•transparent
•objective
•cost-effective
Slide 4

Main Guidelines and Protocols

- U.S. DOE's International Performance Measurement and Verification Protocol (1997)
- U.S. DOE's Voluntary Reporting of Greenhouse Gases (1994)
- USIJI's Project Proposal Guidelines (1996)
- World Bank's Monitoring and Evaluation Guidelines (1994)
- Guidelines for the Monitoring, Evaluation, Reporting, Verification, and Certification (MERVC) for Climate Change Mitigation (LBNL, 1999)
- Final rules for JI projects under Kyoto Protocol will be written by the JI Supervisory Committee established at COP-7

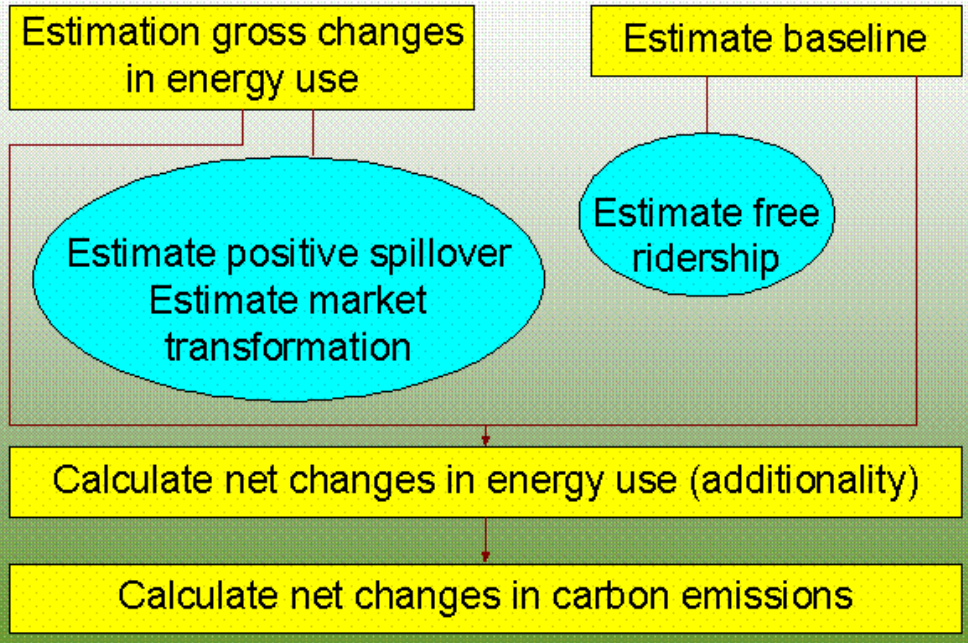
Slide 5

Project Design: Estimation

Estimation refers to making a judgement on the approximate stock of carbon, GHG emissions and costs in the with- and without-project (baseline) scenarios. Estimation can occur throughout the lifetime of the project, but plays a central role during the project design stage when the project proposal is being developed.

Slide 6

Estimation Overview



Slide 7

Project Implementation: Monitoring

Monitoring refers to the measurement of carbon stock, GHG emissions, and costs that occur as a result of the project. Monitoring does not involve the calculation of GHG reductions and does not involve comparisons with previous baseline measurements. Monitoring is often conducted internally, by the project developers.

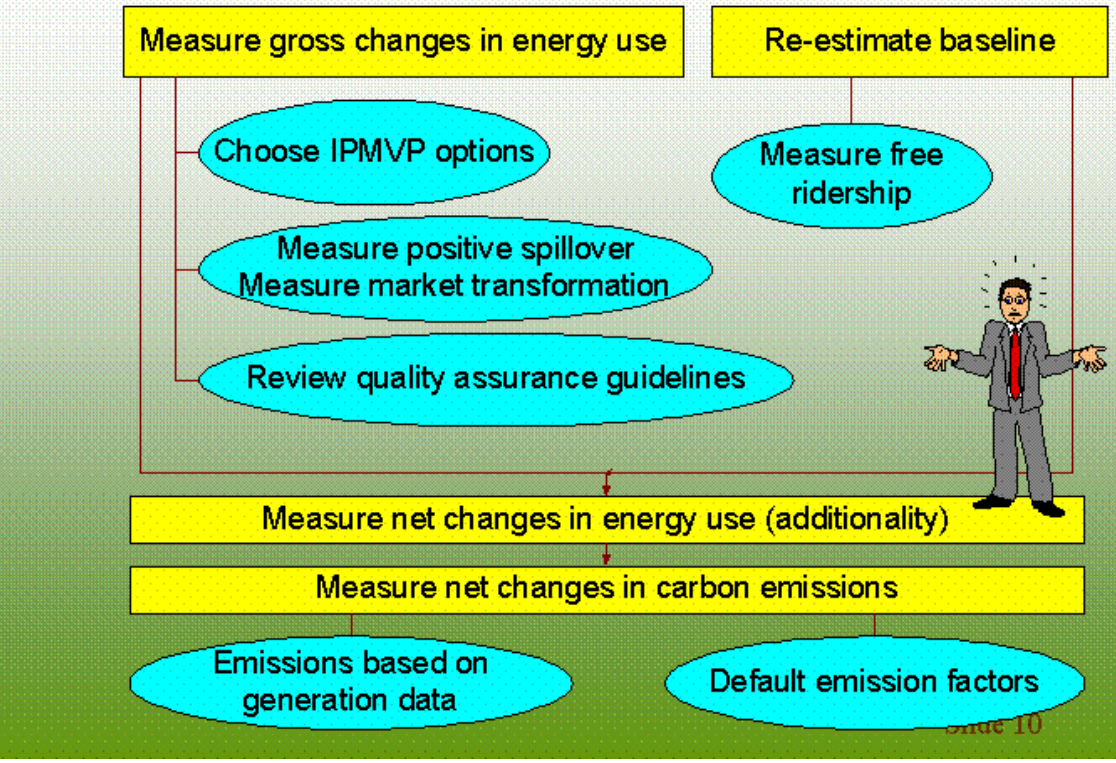
Slide 8

Project Implementation: Evaluation

Evaluation **refers to both impact and process evaluations of a particular project, typically entailing a more in-depth and rigorous analysis of a project compared to monitoring emissions. The calculation of GHG reductions is conducted at this stage. Project evaluation would include GHG impacts, and the re-estimation of the baseline, leakage, positive project spillover, etc., which were estimated during the project design stage. Evaluation organizes and analyzes the information collected by the monitoring procedures, compares this information with information collected in other ways, and presents the resulting analysis of the overall performance of a project.**

Slide 9

Evaluation Overview



Project Implementation: Reporting

Reporting refers to *measured* GHG impacts of the project (in some cases, organizations may report on their *estimated* impacts, prior to project implementation). Reporting occurs throughout the MERVC process (e.g., periodic reporting of monitored results and a final report once the project has ended).

Slide 11

Uniform Reporting Format

- Projected emissions for baseline and project activity scenario
- Cumulative effects for CO_2, CH_4, N_2O, and other GHG
- Environmental and socioeconomic benefits (quantitative and qualitative)
- Compatibility with national economic development, priorities and strategies
- Practical experience gained or technical difficulties, effects, impacts or other obstacles encountered

Slide 12

Project Implementation: Verification

Verification refers to establishing whether the measured GHG reductions actually occurred, similar to an accounting audit performed by an objective, accredited party not directly involved with the project. Verification can occur without certification.

Certification

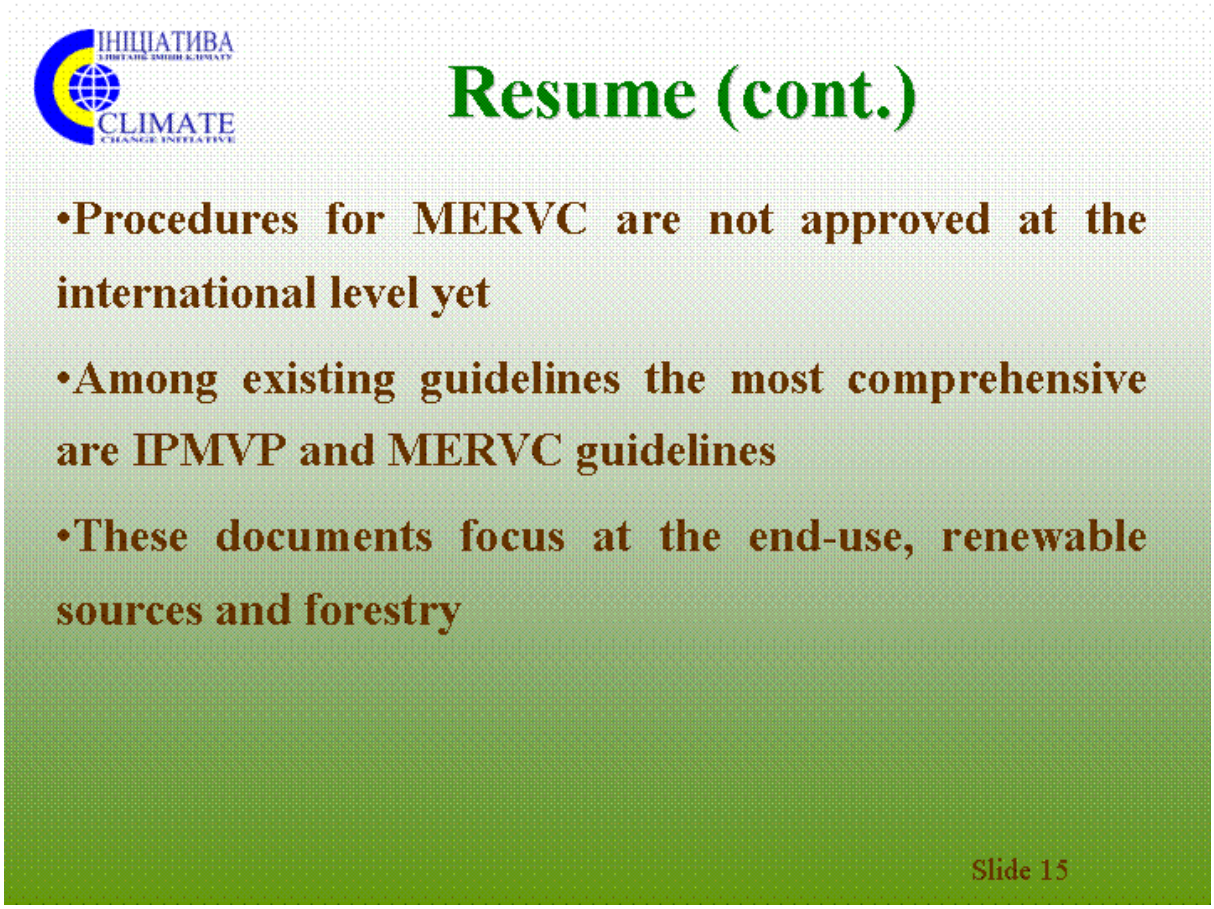
Certification refers to certifying whether the measured GHG reductions actually occurred. Certification is expected to be the outcome of a verification process. The value-added function of certification is in the transfer of liability/responsibility to the certifier.

Slide 13

Resume

- **Specific features of development and realizing JI projects: Estimation, Monitoring, Evaluation, Reporting, Verification and Certification**
- **Verification and Certification should be done by the third party**
- **MERVC activities should be consistent, technically sound, readily verifiable, objective, simple, relevant, transparent, and cost-effective**

Slide 14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CLIMATE
Resume (cont.)
•Procedures for MERVC are not approved at the international level yet
•Among existing guidelines the most comprehensive are IPMVP and MERVC guidelines
•These documents focus at the end-use, renewable sources and forestry
Slide 15

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 16: GHG Baselines: What are they and why do they matter?

Overview

General Objectives: By the end of the session, participants should have a clear understanding of importance of an accurate determination of baselines in the development of JI project ideas. Specifically:

- An adequate definition of baseline emissions is critical for the justification of the environmental benefits generated by a JI project,
- Various approaches are possible for determining. Many issues remain unresolved,
- Baseline approaches differ in costs, transparency, data, and monitoring.

Activities: An overhead slide presentation, followed by period of questions and answers

Total Time: 45 minutes

Materials: Set of 24 OHTs

GHG Baselines: What Are They and Why Do They Matter?

Session 16

Module 2: Economics of Climate Change

Slide 1

Overview of Presentation:

- Background
- Approaches
- Issues
- Sharing of Carbon Credits
- Monitoring and Reporting

Slide 2

Joint Implementation:

- ✓ JI is a *project-based* flexibility mechanism for reducing GHG emissions under the Kyoto Protocol
- ✓ Investor provides capital, financing, access to technology & technical support, etc.
- ✓ This makes possible a project that reduces host entity emissions.
- ✓ The emissions reductions are quantified, and credit is transferable to investor.
- ✓ Time period for crediting emission reductions: 2008 - 2012

Slide 3

Joint Implementation: Who are the Players?

- ✓Host Country
- ✓Investor or Developer
- ✓National JI office
- ✓Operational Entities
- ✓Verification and validation entities

Slide 4

JI Energy Supply Investments: Some Examples

- ✓ Greenhouse Gas Emissions Reduction: (new facilities and retrofits)
  - electricity production (renewables, plant efficiency, fuel switching)
  - natural gas extraction and distribution
  - oil extraction and refining
  - coal mining and processing
  - cogeneration of heat and power
  - district heating

Slide 5

Sequence for JI Project Development

	Document/Activity	Responsible:
Project Design Phase	Project design documents	Project developer
	Baseline study	Project developer
	Monitoring Plan	Project developer
	Validation of project design, baseline study and monitoring plan	Validation/verification bodies
Selection and registration of projects		
Project implementation and Operation Phase	Project design documents	Project developer
	Project design documents	Project developer
	Validation of monitored project emissions	Validation/verification bodies

Source: ERUPT, 2000

Slide 6

What Are Baselines?

- ✓ Baselines are a quantitative reference by which to measure the "***environmental benefits***" of a JI project
- ✓ They are defined as the estimated project emissions ***in the absence of the JI project***
- ✓ They are the emissions that would have otherwise happened. They are not ***monitored***

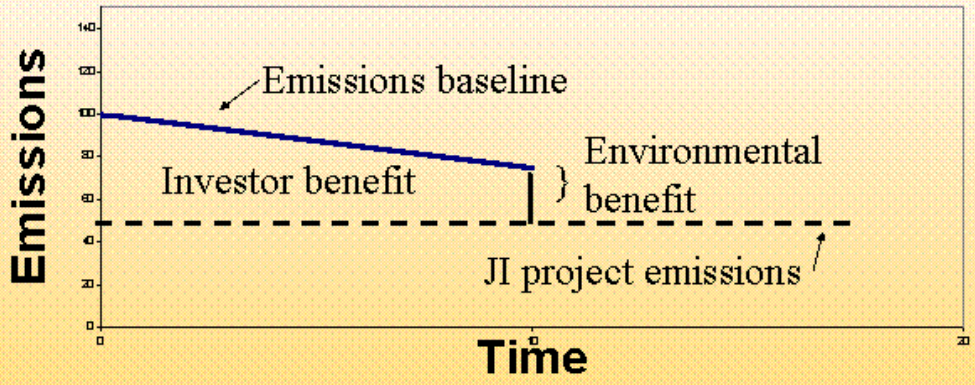
Slide 7

Why do We Need Baselines?

- ✓ JI projects must result in "*measurable" environmental benefits*
- ✓ Impossible to claim *that a project yields "measurable environmental benefits"* without a quantitative reference scenario
- ✓ Thus, baselines are extremely important because they are the basis for determining earned "***emission reduction units***" for a project

Slide 8

Baseline Terms



Slide 9

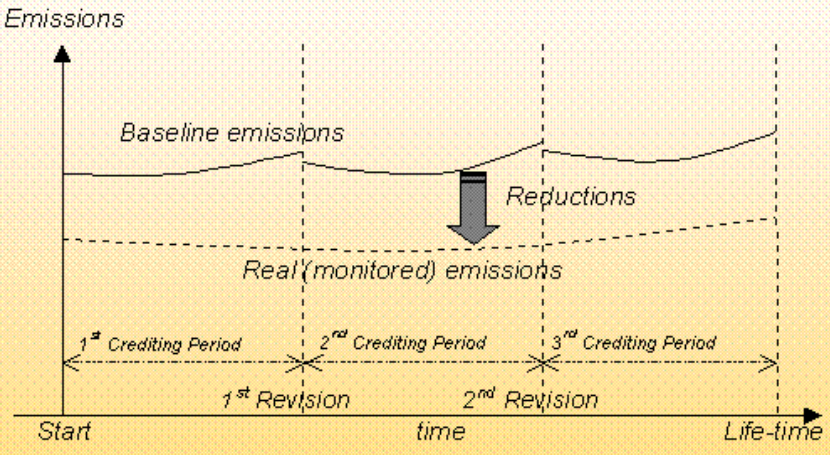
Emissions Additionality

"... and reductions of emissions that are additional to any that would occur in the absence of the certified project activity." [Kyoto Protocol]

- ✓ What would have occurred otherwise?
- ✓ What is the counter-factual "baseline" situation ?
- ✓ What are the project emissions?
- ✓ What no-regrets options are additional?
- ✓ Might there be significant leakage ?
- ✓ *JI* based on closed transfers

Slide 10

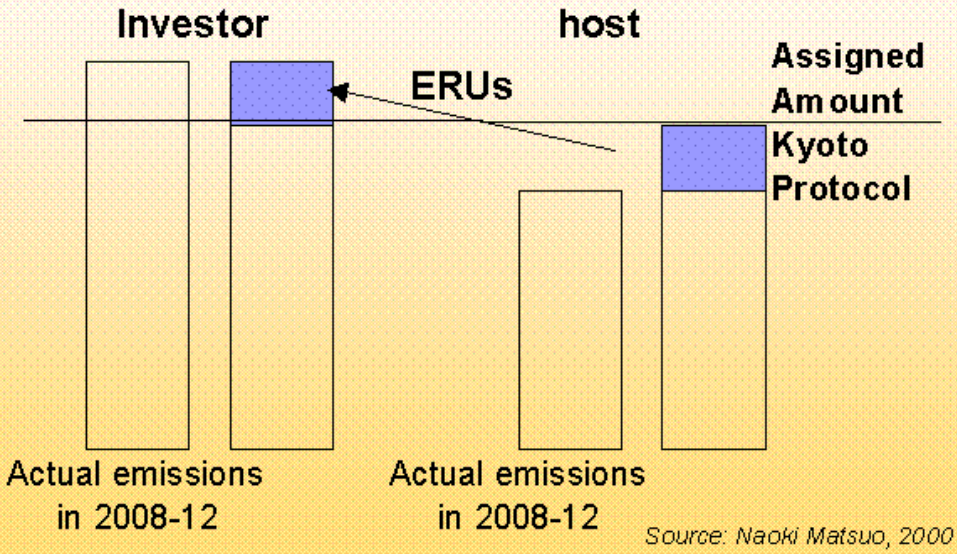
What Do We Mean by "Additionality" ?



Source: Naoki Matsuo, 2000

Slide 11

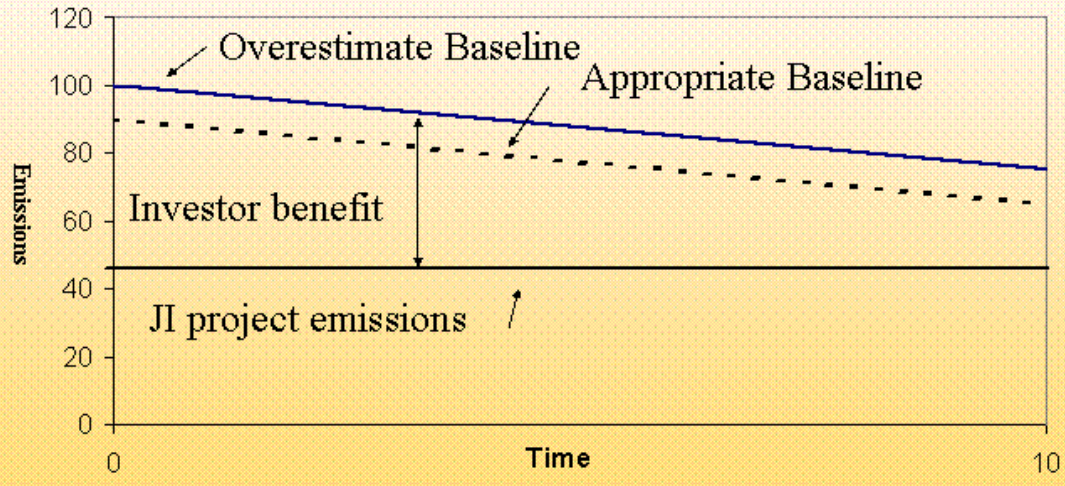
Earned Reduction Unit Transfer from Host to Investor



Source: Naoki Matsuo, 2000

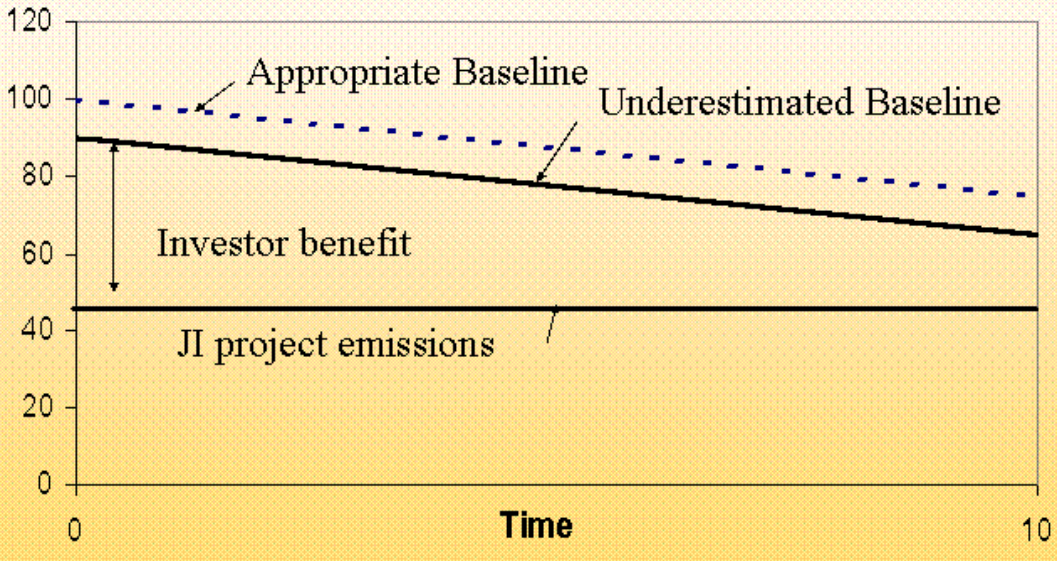
Slide 12

Impact of Overly Lax Baselines



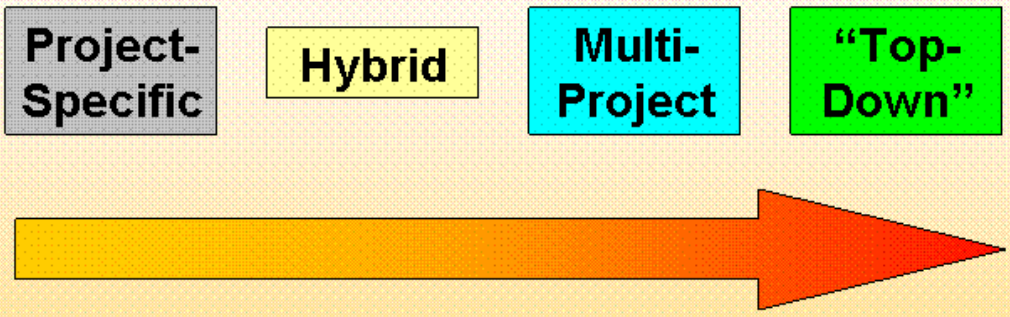
Slide 13

Impact of Overly Stringent Baselines



Slide 14

Baseline Approaches



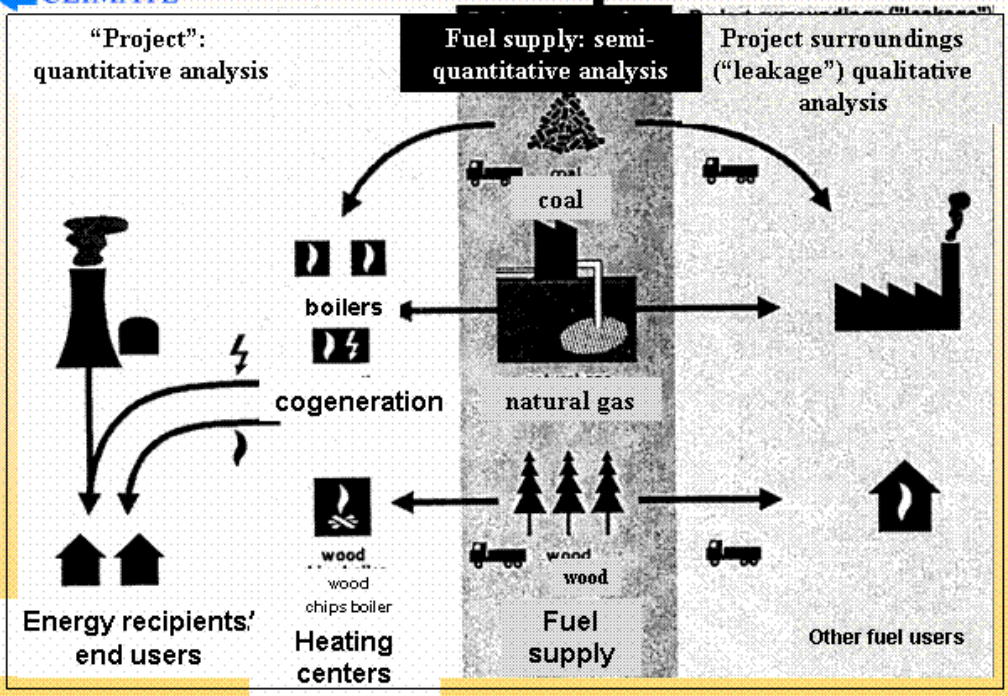
Slide 15

What Are the Major Approaches to Setting a Project Baseline?

- ✓ Method-based approaches
- ✓ Comparison-based approaches
- ✓ Simulation-based approaches
- ✓ Mixed-use approaches
- ✓ Existing approaches used by the international community

Slide 16

Range of GHG Emission Impacts



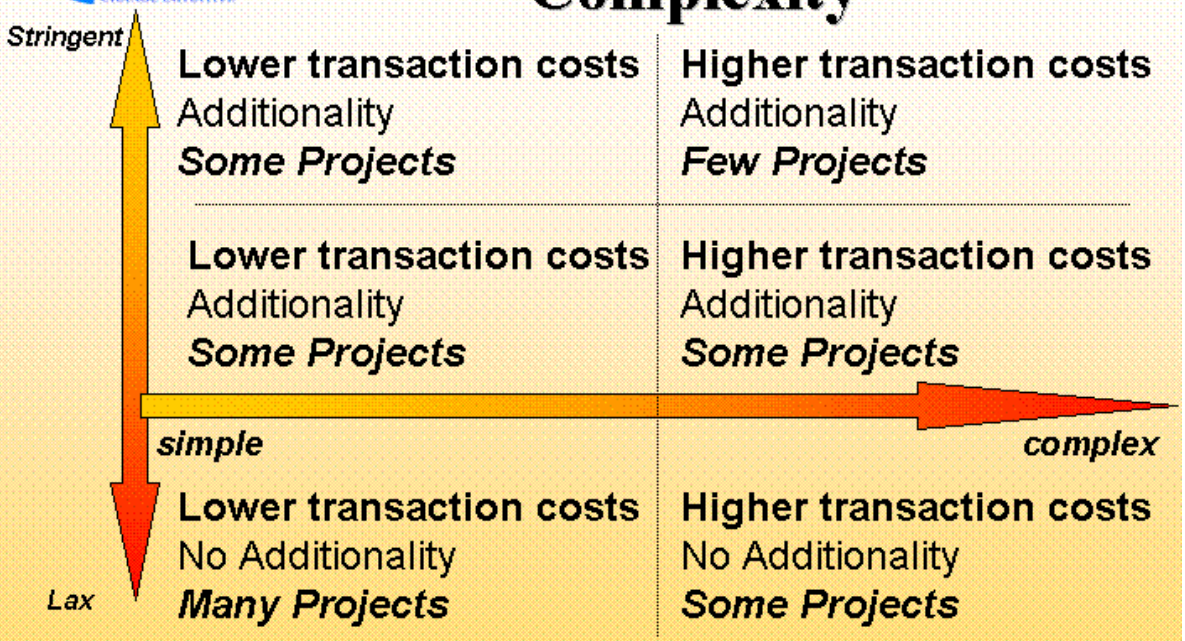
Slide 17

Major Issues in Setting Baselines

- ✓ Comparing Environmental vs. Economic Efficiency
- ✓ Establishing Evaluation Criteria
  - Credibility
  - Simplicity
  - Transparency
  - Crediting Certainty
  - Understanding the tradeoffs

Slide 18

Effect of Baseline Stringency & Complexity



Source: Ellis, 1999

Slide 19

Other Major Issues in Setting Baselines

- ✓ Environmental credibility (i.e., "gaming")
- ✓ Free-riding
- ✓ Leakage
- ✓ Accounting: income and substitution effects
- ✓ Economic and commercial viability
- ✓ Timeline

Slide 20

Approaches to Sharing of Carbon Credits

- ✓Abatement approach
- ✓Investment approach
- ✓Incremental cost approach

Slide 21

Performance Monitoring, Reporting, and Evaluation

- ✓Measure GHG emissions from JI project
- ✓Explain differences
- ✓Determine secondary effects of project
- ✓Parameters and formula

Slide 22

Conclusions

- ✓ Determining baseline emissions is critical
- ✓ Many technical details remain unresolved
- ✓ Various approaches are possible
- ✓ Cross-cutting issues are relevant to all baselines
- ✓ Baseline approaches differ in costs, transparency, data, and monitoring
- ✓ Final JI rules will be written by the JI Supervisory Committee established at COP-7

Slide 23

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 17: GHG Baselines: How Are They Determined?

Overview

General Objectives: By the end of the session, participants should have a clear understanding of the principles, issues, and calculations involved in determining project-level baselines and carbon credits from JI projects. Specifically:

- The approach used for calculating the baseline must account for the current and expected situation
- Once determined, project baselines are fixed at the start of the JI project
- Carbon reduction credits are based on straightforward calculations on the basis of carbon intensity differences
- Analytical tools using spreadsheet models can provide a transparent framework for examining carbon reductions.

Activities: An overhead slide presentation, followed by period of questions and answers

Total Time: 45 minutes

Materials: Set of 23 OHTs

GHG Baselines: How Are They Determined?

Session 17

Module 2: Economics of Climate Change

Slide 1

Overview of Presentation:

- Background
- Types of projects
- Principles
- Issues
- Major Calculations

Slide 2

Types of Projects Considered in this Training

- ✓Power Supply
  - Replacement of an existing power station
  - Efficiency improvements to existing power station
  - Installation of a new Power Station
- ✓District Heating Systems
  - Fuel switching at an existing facility
  - Efficiency improvements to existing facility
  - Conversion of an existing facility to CHP

Slide 3

Types of Projects Baselines Considered in this Training (cont'd)

- ✓Industrial Boilers
  - Fuel switching to a lower intensity carbon fuel
  - Efficiency improvements to existing boiler
  - Conversion of an existing facility to CHP
- ✓Coal Bed Methane
  - Capture of methane emissions from an existing mine

Slide 4

Basic Concern of Baselines

- ✓ *Would the project have proceeded even without the availability of emission credits?*
- ✓ Example: Diesel generator replacement
  - End of useful life?
  - Changes in supply conditions?
  - Changes in price
- ✓ Impact on national resource allocations

Slide 5

Principles in Defining Baselines

- ✓ First: Understand what recent experience tells us
- ✓ Second: Define the attributes needed for successful baseline methodologies
- ✓ Third: Decide on the baseline approach
- ✓ Fourth: Clarify conceptual issues
- ✓ Fifth: Understand the cost implications

Slide 6

Static and Dynamic Baselines

- ✓Earlier presentation touched on this
- ✓Static baseline : point of comparison constant over time
- ✓Dynamic baseline: point of comparison projected to change over time

Slide 7

Sources of Uncertainty

- ✓Future changes in fuel supply
- ✓Future changes in dispatch and performance
- ✓Example: Gas-fired power station
- ✓Calculation:

$$(I_{ex} - I_{ji}) \times G_{ji} = Carbon\ reduction\ (t\ CO2)$$

Slide 8

Determinants of Baseline Emissions and Reduction Credits

- ✓Project period and timing
- ✓Equivalent energy services

Slide 9

Key Concepts in Baseline Emissions and reduction credits

- ✓project baselines are ***fixed*** at the start of the JI project
- ✓Carbon reduction credits are calculated on the basis of carbon intensity differences

Slide 10

Step by Step Approach to Baseline Development

- ✓ Describe the context of the project (i.e., current situation/problem)
- ✓ Characterize the JI project
- ✓ Verify the the project is "additional"
- ✓ Describe the baseline characteristics
- ✓ Quantify GHG baseline emissions
- ✓ Quantify JI project GHG emissions
- ✓ Estimate reduction impact

Slide 11

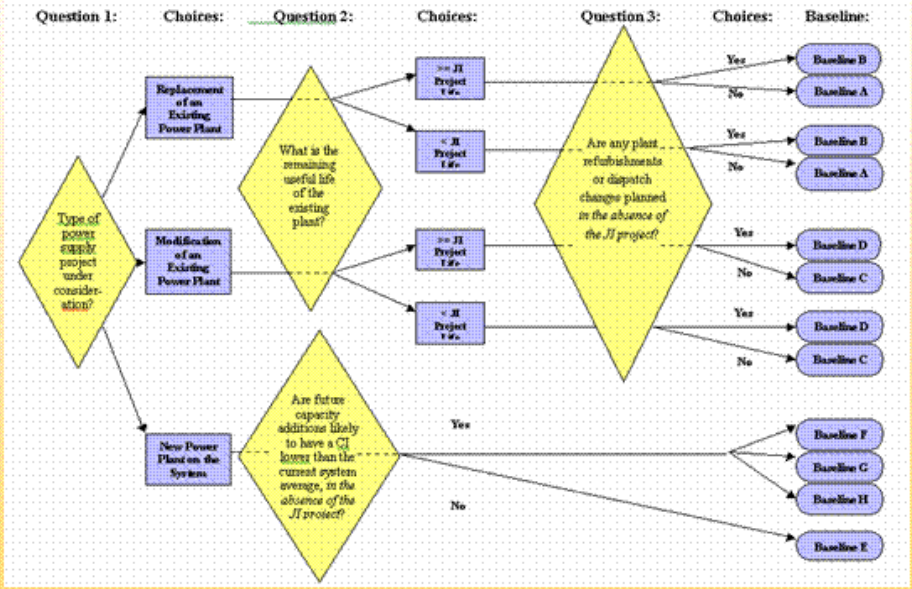
Step by Step Approach using a Decision Matrix

- ✓ *Decision matrix helps to identify*
  - What projects would qualify as a JI investment (from national perspective)
  - The key decisions made in development of the baseline (i.e., transparency)
  - What type of baseline approach is appropriate
  - Whether a static or dynamic approach should be used

Slide 12

Baseline Decision Protocols

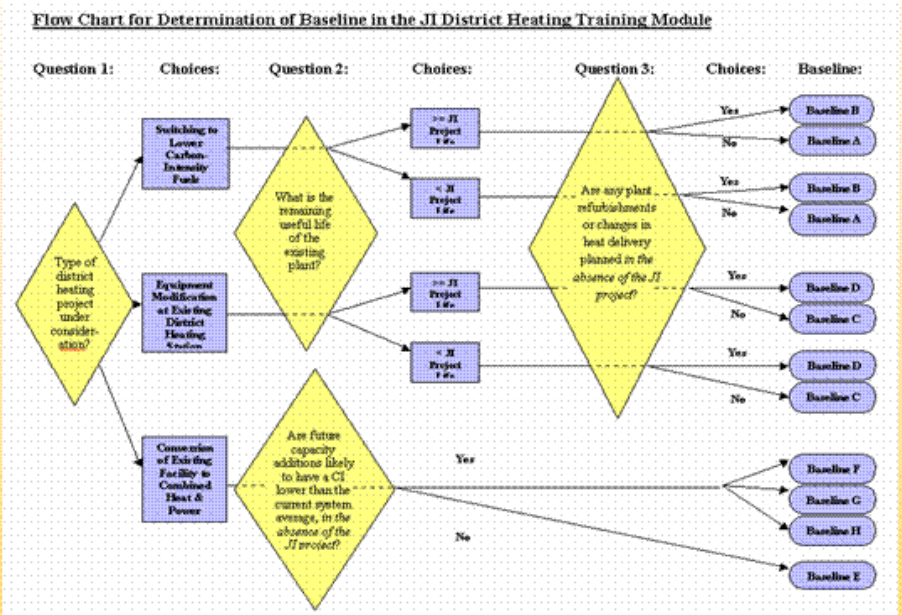
Flow Chart for Determination of Baseline in the JI Power Supply Training Module



Slide 13

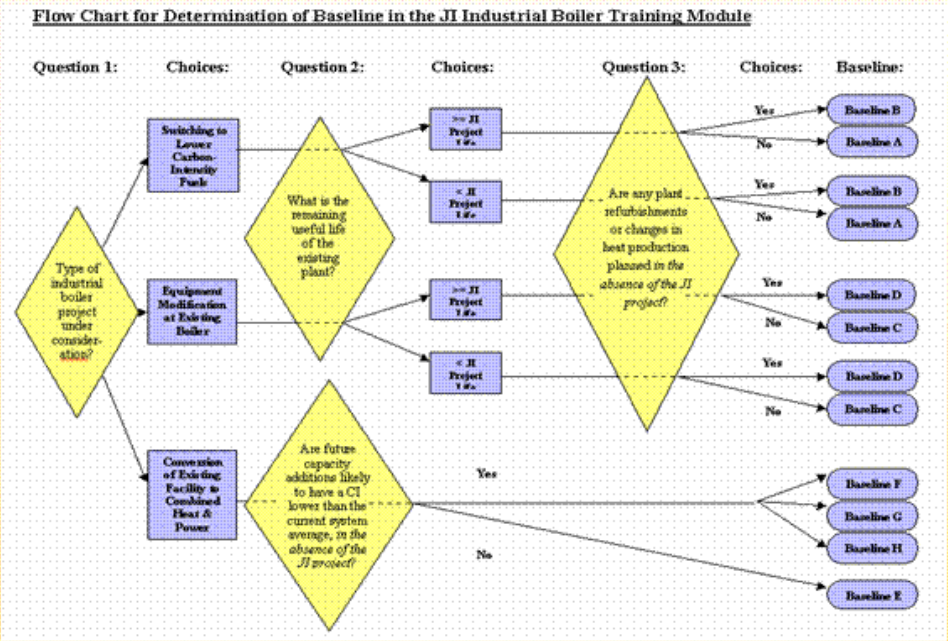
Baseline Decision Protocols

Flow Chart for Determination of Baseline in the JI District Heating Training Module



Slide 14

Baseline Decision Protocols



Slide 15

Major Calculations: CO2-equivalence

- ✓ Major Greenhouse gases:
  - Carbon dioxide (CO2)
  - Methane (CH4)
  - Nitrous Oxide (N2O)
- ✓ Global Warming Potential (GWP)
  - CO2= 1; CH4 = 21; N2O = 310
- ✓ Total CO2-equivalent emissions:

$$CO2\text{-}equiv = 1 \times (mass\ of\ CO2) + 21 \times (mass\ of\ CH4) + 310 \times (mass\ of\ N2O)$$

Slide 16

Major Calculations (cont'd): CO2 from Fossil Fuel Combustion

- ✓ Premises:
  - Carbon content is known
  - Almost all of the carbon is converted to CO2
- ✓ Steps:
  - Estimate consumption of fuel (in mass or volume units)
  - Convert to energy units
  - Identify oxidation percentage
  - Multiply by adjusted CO2 emissions factor
- ✓ Total CO2 emissions:

CO2 = (mass/volume of fuel) x (energy content of fuel) x (oxidation level) x (CO2 emission factor)

Slide 17

Major Calculations (cont'd): Energy from a Power Station

- ✓ Premises:
  - Energy lost converting combustion heat to steam
  - Energy lost converting steam energy to electric energy
  - Some electricity is used for auxiliary equipment on site
  - Some electricity produced is lost in the T&D system
- ✓ Steps:
  - Estimate total level of losses (in percent)
  - Identify level of electricity used on site
- ✓ Efficiency (%) of energy use ($3{,}600/(Gj_{in}/GWh_{out})$):

Efficiency = 3,600 / ((total energy consumed at plant) / (total electricity produced at plant))

Slide 18

Major Calculations (cont'd): CO2 Intensity from a Power Grid

- ✓ Premises:
  - Network of power stations
  - Network of transmission and distribution lines
  - Large number of electricity consumers
  - Changes to the network take place over time
- ✓ Steps:
  - Calculate energy used and emissions for each station
  - Calculate emission intensity - electricity produced (gross)
  - Calculate emission intensity for electricity consumed (net)
- ✓ CO2 intensity :

  Gross intensity: CO2 emissions / total electricity produced

  Net intensity CO2 emissions / total electricity consumed

Slide 19

Major Calculations (cont'd): Energy from a Thermal Station

- ✓ Premises:
  - Energy lost converting combustion heat to steam
  - Energy lost in steam distribution system (if applicable)
- ✓ Steps:
  - Estimate total level of losses (in percent) in conversion of heat to steam (L_1)
  - Estimate total level of losses (in percent) in distribution of steam (if applicable) (L_2)
- ✓ Energy Losses (GJ)

  $= Energy\ use\ at\ site \times (1- L_1) \times (1-L_2)$

Slide 20

Major Calculations (cont'd): Energy from District Heating

- ✓ Premises:
  - Energy lost converting combustion heat to steam
  - Energy lost in steam distribution system
- ✓ Steps:
  - Estimate total level of losses (in percent) in conversion of heat to steam (L_1)
  - Estimate total level of losses (in percent) in distribution of steam (L_2)
- ✓ Energy Losses (GJ)

$$= \textit{Energy use at site} \times (1 - L_1) \times (1 - L_2)$$

Slide 21

Analytical Framework for Calculating Emissions

- ✓ Calculation described have been integrated into a tool for conducting case study work in working group exercises
- ✓ Several case study examples have been developed
- ✓ Cases analyzed are only a subset
- ✓ Results subject to evaluation and critique.

Slide 22

Conclusions

- ✓ Project baselines are ***fixed*** at the start of the JI project
- ✓ Carbon reduction credits are calculated on the basis of carbon intensity differences
- ✓ Baseline approach must take account of current and expected situation
- ✓ Major calculations are straightforward
- ✓ Analytical tool provides a framework for examining carbon reductions
- ✓ Final rules for JI projects under Kyoto Protocol will be written by the JI Supervisory Committee established at COP-7

Slide 23

MODULE II: ECONOMICS OF CLIMATE CHANGE

Session 18: Financial & Economic Assessments of Projects (part I and II)

General Objectives: Session 18 is intended to provide an overview of the goals and objectives of financial and economic analysis. Session 18 will begin with a review of the differences between conducting a financial analysis and conducting an economic analysis. By necessity, the session will need to introduce and discuss what may be to at least some of the participants' new terminology such as discount rate cash flows, and net present value. The session will also provide an overview of the basic tools and steps involved in financial and economic analysis. Session 18 (part II) is intended to directly follow Session 18 (part I) and will provide an overview of sensitivity analysis, capital outlays and financing structure, income streams and expense projections. By the end of both sessions, participants should have a basic understanding of:

- The key indicators involved in the assessment of project financial performance
- The issues and concepts involved in converting from project financial to economic analysis
- The basic steps in determining project financial and economic additionally,
- income streams, expense projections)

Activities: 2 Presentations, followed by period of questions and answers

Total Time: Total of 90 minutes

Materials: 2 sets OHTs (38+14).

Financial & Economic Assessments of Projects (part I)

Session 18
Module 2: Economics of Climate Change

Slide 1

Outline of Topics -1

- Objectives of financial and economic (F&E) analysis.
- Differences between F&E analysis.
- Introduction to project F&E analysis terminology.
- What is a discount rate? / time value of money?
- How to determine the applicable discount rate?
- Discounting cash flows for net present value.
- Setting up the project cash-flow pro forma.

Slide 2

Outline of Topics -2

- Differentiating sources of project finance:
  - Debt / Subordinated Debt / Equity / Grant.
- Basic tools for project financial analysis.
- Basic steps in project financial analysis.
- Key indicators of project financial performance.
- Converting project financial to economic analysis.
- Key indicators of project economic performance.
- Determining project financial and economic additionality.

Slide 3

Objectives of Project F&E Analysis

- Project **financial analysis** is used as a tool by project developers, owners, investors and others to rank and make investment decisions.
- Project **economic analysis** is used by government agencies, multilateral development institutions and NGOs to rank or determine the "social values" or "benefits" to society of project investments.
- Project F&E analysis helps make decisions about and between projects - helps set priorities.

Slide 4

Differences Between F&E Analysis

- **Financial analysis** accounts for the perspective or concerns of the individual participants, investors or organizations in the project:
  - Uses actual market prices that include taxes and subsidies;
  - Accounts for interests paid to external suppliers of capital;
  - Accounts for all taxes, royalties, license fees, development grants and other transfer payments.

Slide 5

Differences Between F&E Analysis

- **Economic analysis** accounts for the perspective or concerns of society or the national economy.
  - Uses "economic prices" -i.e., prices that remove the transfer payments of taxes, subsidies, etc.;
  - Does not account of the interests on capital which is a transfer of payments to the owners of capital;
  - Adjusts to economic values for artificial or fixed exchange rates, labor rates, rents, etc.;
  - Adjusts for regulations, market constraints or "externalities".

Slide 6

Project F&E Analysis Terminology-1

- Costs - the payments made in the project for equipment/capital, land, labor and management:
  - Payments are made in the form of prices, interests, rents, wages and salaries;
  - Costs can be divided into fixed costs and variable costs.
- Revenues/Income -the money returns from the outputs of a project.
- Benefits - includes the monetary and non-monetary returns from the outputs of a project.

Slide 7

Project F&E Analysis Terminology-2

- Cash Flow - the accounting of project costs and income over time (e.g., daily, weekly, monthly, annually).
- Interest Rate - the price paid for borrowing money represented usually as an annual rate or percentage of the amount borrowed.
- Discount Rate - a measure of the "time value" of money - the interest rate used to determine the present value of a future value by discounting.
- Inflation Rate- the rate of increase in prices.

Slide 8

Project F&E Analysis Terminology-3

- Benefit-Cost (B/C) Ratio - the ratio of all benefits from a project to the costs of a project.
- Present Value (PV) - the value in year 0 (present) of a discounted flow of money (costs or revenues).
- Net Present Value (NPV) - the discounted value of the difference between the revenues and costs.
- Internal Rate of Return (IRR)- a measure of the discounted worth of the projects net benefits- i.e., the discount rate that makes the NPV of the project equal to zero (NPV=0)

Slide 9

Confused? - Don't Worry!!!

- F&E analysis requires a good understanding of the terminology.
- F&E analysis can be done with the aid of computer spreadsheets:
  - Spreadsheets are only accurate when the data inputs are accurate;
  - Spreadsheets are only accurate when the formulas used are correct;
  - Spreadsheets are only accurate when you understand what you are doing.

Slide 10

What is a Discount Rate?

- The Discount Rate is a measure of the "time value of money" or the "opportunity cost of capital".
- The Discount Rate will vary among different entities:
  - private or individual discount rate - usually high because of immediate needs;
  - corporate or organizational discount rate - varies but usually below individual rates and above bank loan rates;
  - investor discount rate - usually equal to the market interest rates for long term borrowing;
  - society or government discount rate - usually equal to international borrowing rates.

Slide 11

Using the Discount Rate

- The discount rate is used to determine the present value (PV) of a future value (FV) as follows:

  $PV = FV*(1/(1+d)^n)$

  where:

  d = the discount rate (in percentage) per period;

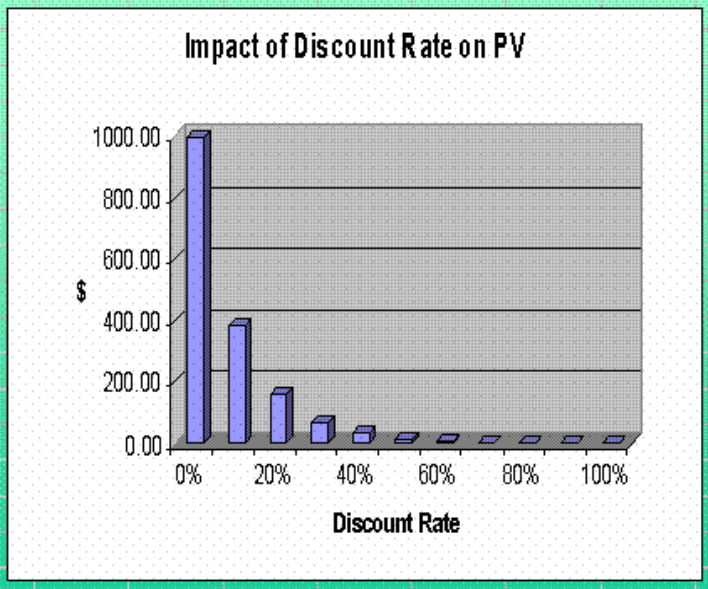
  n = number of periods (e.g., years).
- Similarly, the future value (FV) of a PV is:

  $FV = PV*(1+d)^n$

Slide 12

Effect of the Discount Rate on the PV of FV of $1000 in 10 Years

Future Value	$1,000.00
in year	10
Discount Rate	PV
0%	1000.00
10%	385.54
20%	161.51
30%	72.54
40%	34.57
50%	17.34
60%	9.09
70%	4.96
80%	2.80
90%	1.63
100%	0.98

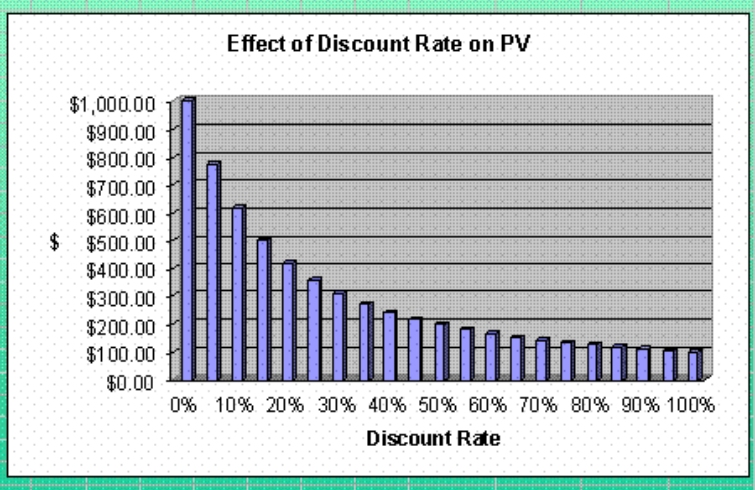


Slide 13

Effect of Discount Rate on the PV of a 10 year Annuity of $100

Year	0	1	2	3	4	5	6	7	8	9	10
Income		100	100	100	100	100	100	100	100	100	100

Discount Rate	PV
0%	$1,000.00
5%	$772.17
10%	$614.46
15%	$501.88
20%	$419.25
25%	$357.05
30%	$309.15
35%	$271.50
40%	$241.36
45%	$216.81
50%	$196.53
55%	$179.55
60%	$165.15
65%	$152.82
70%	$142.15
75%	$132.84
80%	$124.65
85%	$117.40
90%	$110.93
95%	$105.13
100%	$99.90



Slide 14

Setting Up Project Cash Flow / Pro-Forma

- First step in project financial analysis is to estimate the cash flow.
- The cash flow is the time representation of all money flows out (costs) and into (revenue /income) a project.
- Net cash flow is the difference between income and costs.
- Cash flow is different from the accounting done to determine profits. For example it ignores depreciation or outstanding loans.

Slide 15

Cash Flow vs. Financial Accounting

Item	Cash Flow	Accounting
Expenditures	When cash is paid out	When order is placed
Revenues	When cash is received	When sale occurs
Loan	When loan is received	Noted as a liability
Interest on loan	When paid	When due
Depreciation	Not included	Included
Taxes	When paid	When incurred
Wages	When paid	When work is done

Slide 16

Cash Flow Projections-Main Concepts

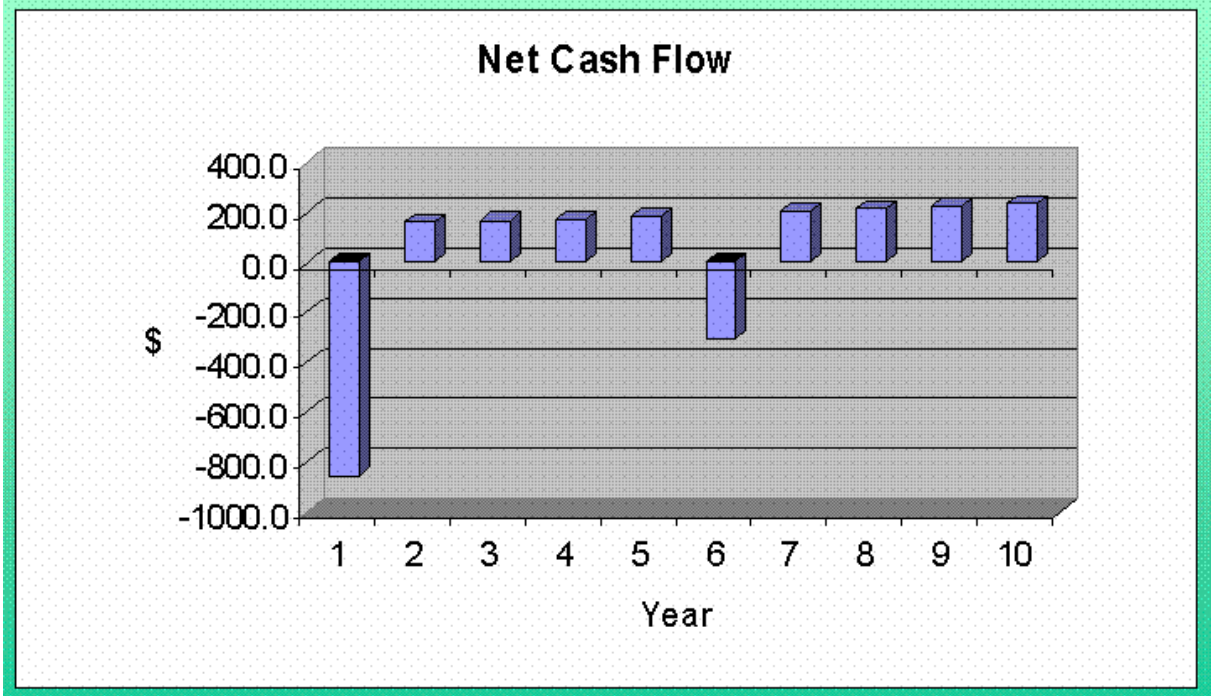
- Project costs and revenues of project in terms of actual cash flow NOT earnings
- Convention: assume cash flows occur at end of each period unless otherwise stated.
- Include all capital, rent, operation, maintenance and fuel costs when incurred
- Include all revenues from sales of project outputs, services or salvage value of equipment.

Slide 17

Example Cash Flow Statement

Year	1	2	3	4	5	6	7	8	9	10
Costs										
Capital	-1000.0					-500.0				
O&M	-100.0	-105.0	-110.3	-115.8	-121.6	-127.6	-134.0	-140.7	-147.7	-155.1
Fuel	-200.0	-210.0	-220.5	-231.5	-243.1	-255.3	-268.0	-281.4	-295.5	-310.3
Other	-50.0	-52.5	-55.1	-57.9	-60.8	-63.8	-67.0	-70.4	-73.9	-77.6
Total Costs	-1350.0	-367.5	-385.9	-405.2	-425.4	-946.7	-469.0	-492.5	-517.1	-543.0
Revenues										
Electricity Sales	400.0	420.0	441.0	463.1	486.2	510.5	536.0	562.8	591.0	620.5
Carbon Credits	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Other (e.g, heat)	100.0	105.0	110.3	115.8	121.6	127.6	134.0	140.7	147.7	155.1
Total Revenues	500.0	525.0	551.3	578.8	607.8	638.1	670.0	703.6	738.7	775.7
Net Cash Flow	-850.0	157.5	165.4	173.6	182.3	-308.6	201.0	211.1	221.6	232.7
IRR	7.6082%									
Discount Rate	5%	7.6082%	10%							
NPV	$103.08	$0.00	($75.36)							

Slide 18



Slide 19

Financing the Project

- A company/developer can finance a project in a number of ways:
  - Equity or self-financing--use internal funds--cash reserves. Risks are borne by the company/developer.
  - Debt-financing-- borrow a loan to finance the project. Requires security - recourse vs. non-recourse.
  - Convertible/Subordinated debt -- loans that can convert to equity in the project if not repaid.
  - Financial leases -- usually available for major equipment, land and buildings.
  - Supplier credits -- available for major equipment and inventory.

Slide 20

Project Finance

- Most MDBs and banks use Project Finance--means that the lender does not finance the company, but finances the project itself.
- Investors look to the anticipated cash flow of the project itself for repayment of the principal and interest on the loan and for the return on the investment.
- Non-recourse financing--project's assets, contracts and cash flow serve as collateral and not the assets of the company or project developer.

Slide 21

Key Requirements for Project Finance-1

- Detailed and precise cost estimates and contracts for construction, O&M and fuel to control the cost stream.
  - Reputable project contractors;
  - Reliable project operator;
  - Predictable O&M Expenses;
  - Proven technology and performance;
  - Long-term fuel contracts;
  - Long-term labor contracts;
  - Stable prices of non-contracted inputs.

Slide 22

Key Requirements for Project Finance-2

- Detailed and precise long-term contracts for sale of outputs and services to secure the minimum revenue stream:
  - Secure and predictable revenue flow;
  - Long term purchase contracts for outputs and services;
  - Assured payment of revenues (take or pay contracts);
  - Stable prices for outputs and services;
  - Currency convertibility;
  - Reliable and creditable buyers of outputs and services.

Slide 23

Key Requirements for Project Finance-3

- Technical viability of project operations;
  - proven equipment/process conversion efficiencies;
  - proven equipment/process reliabilities;
  - proven equipment life/salvage value;
- Financial viability of project operations:
  - Sufficient cash-inflow to fund operations and service debt at all times;
- Stable regulatory and legal framework.

Slide 24

Basic Tools for Project Financial Analysis

- A well defined project cash flow / pro-forma.
- Excel spreadsheet or understandable financial analysis models: - Proform; RETScreen;
- Defined and defensible basic financial indicators including:
  - inflation rates;
  - interest rates;
  - discount rate;
  - currency exchange rates.

Slide 25

Basic Steps in Project Financial Analysis

- Get all your input data for the project pro-forma.
- Determine the type of financial indicators your want to use to analyze project financial performance.
- Carry out the analysis;
- Identify principal areas of project risk.
- Conduct sensitivity analysis to assess project risk.
- If assessing JI project, define baseline project and assess financial additionality of JI project.

Slide 26

Key Indicators of Project Financial Performance {Simple Payback}

- Simple Payback (SP) = measures the number of years it will take for un-discounted net cash flow (revenues) to repay the initial investment.
  - Criterion is set to accept projects that have a simple payback within the shortest period of time.
  - Difficult to use for projects with complex cash-flows (investments in more than one period).
  - Not necessary that projects with the shortest payback period is the financially the most attractive or profitable.
  - Biased against projects with high capital cost and long gestation periods - e.g, renewable energy projects.

Slide 27

Key Indicators of Project Financial Performance {Discounted Payback}

- Discounted Payback (DP) = measures the number of years it will take for discounted net cash flow (revenues) to repay the initial investment.
  - Criterion is set to accept projects that have a discounted payback within the shortest period of time.
  - Difficult to use for projects with complex cash-flows (investments in more than one period).
  - Not necessary that projects with the shortest payback period is the financially the most attractive or profitable.
  - Biased against projects with high capital cost and long gestation periods - e.g, renewable energy projects.

Slide 28

Key Indicators of Project Financial Performance {Financial Net Present Value}

- Financial Net Present Value (FNPV) = the present value of the discounted net cash flow.
  - Criterion is to accept all independent projects[1] with a FNPV >0 when discounted at a "suitable" discount rate.
  - The analysis is highly dependent on the assumed discount rate - usually the estimate of the opportunity cost of capital for the project proponent.
  - When assessing mutually exclusive alternatives[2] - the criteria is to accept the project with the highest NPV.
  - Does not ensure that the project with the highest NPV will also yield the highest IRR or be the most profitable.

1. Independent projects indicate that undertaking one project does not preclude or prevent undertaking the others. As opposed to Mutually Exclusive projects which imply that if one project is undertaken by its very nature the other alternative cannot be undertaken.

Slide 29

Key Indicators of Project Financial Performance {Financial Benefit/Cost Ratio}

- Financial Benefit/Cost Ratio (FBCR) = the financial present value of the benefit (revenue or income) flow divided by the financial present value of the cost flow
  - FBCR = FPV of Income / FPV of Revenues.
  - Criterion is to accept all independent projects with a FBCR>1 when discounted at a "suitable" discount rate.
  - The analysis is highly dependent on the assumed discount rate - usually the estimate of the opportunity cost of capital for the project proponent.
  - May give incorrect ranking for independent projects and cannot be used for choosing among mutually exclusive alternatives.

Slide 30

Key Indicators of Project Financial Performance {Financial Internal Rate of Return}

- Financial Internal Rate of Return (FIRR) = the interest rate or rate of return on on capital outstanding per period while it is invested in the project. Sometime also referred to as the FIRR on equity.
  - Criterion is to accept all independent projects with an FIRR that is greater than an "acceptable cut-off rate" which is usually the opportunity cost of capital of the investors.
  - May give incorrect ranking among independent projects.
  - Cannot be used directly for choosing among mutually exclusive projects.
  - The IRR indicates the maximum interest rate a project can pay for the resources used if the project is to recover its investment and operating expenses and still break even. It is equal to the discount rate that makes the NPV of the net cash flow equal zero.

Slide 31

Key Indicators of Project Financial Performance {Least Cost or Cost Effectiveness Ratio}

- Cost Effectiveness Ratio = The NPV of costs divided by the output of benefits that are measured in non-monetary units.
  - Usually used for analyzing projects that provide benefits that cannot be reasonably measured in monetary terms (e.g, measuring the cost effectiveness of GHG mitigation).
  - Criterion is to select the project with the least cost or lowest cost effectiveness ratio for a given type of benefit assuming all other project benefits are held constant.
  - It is impossible to obtain a full measure of "project worth" from cost effectiveness analysis since the analysis is done without reference to the value to users of the project output.

Slide 32

Converting from Financial to Economic Analysis

- Economic analysis is carried out from the perspective of society or the national economy.
- To convert a financial analysis to an economic analysis one needs to omit all ***transfer payments*** and value all items at their ***opportunity cost to society***. Thus
  - eliminate credit transactions or payment of interests;
  - eliminate taxes, subsides and other price distortions or supports;
  - value all inputs and outputs at their opportunity cost to society - usually international border prices or unregulated prices;
  - use free market exchange rates or "shadow" exchange rates;
  - use free market labor rates, rents, commodity prices, etc.

Slide 33

Key Indicators of Project Economic Performance

- Once the the financial pro-forma has been adjusted to eliminate all transfer payments and reflect economic costs, project economic performance indicators, that mirror the financial performance indicators can be developed.
- The most common project economic performance indicators used include:
  - Economic Net Present Value (ENPV);
  - Economic Internal Rate of Return (EIRR);
  - Economic Benefit/Cost Ratio (EBCR);
  - Economic Cost Effectiveness Ratio (ECER).
- The project selection criterion and restrictions are similar to those given for the financial performance indicators.

Slide 34

Determining the Financial and Economic Additionality of Projects

- Estimating the financial and economic additionality of projects requires defining a baseline against which the "additionality" of the alternative can be measured.
- Who has the responsibility for defining the baseline for JI projects?
  - The ultimate responsibility must be with the host country.
  - The actual responsibility will fall to the project developer / investor.
  - Validation and certification will discourage inflating of baselines.
- What factors should be considered in defining the baseline?
  - Current trends in technology and practice.
  - Financial optimums.
  - Economic optimums.
  - Projections / simulations of future expectations.

Slide 35

Project Financial and Economic Additionality

- ***Financial Additionality*** - define the financial present value of all capital and O&M costs (FPVC) for the JI project and the baseline project. Determine if the financial present value of the costs for the JI project is greater than the present value of the costs for the baseline project. If $\mathbf{FPVC_{JI} > FPVC_b}$, then the JI project is financially additional to the baseline. If not, the JI project is not financially additional.
- ***Economic Additionality*** - define the economic present value of all capital and O&M costs (EPVC) for the JI project and the baseline project. Determine if the economic present value of the costs for the JI project is greater than the present value of the costs for the baseline project. If the $\mathbf{EPVC_{JI} > EPVC_b}$, then the JI project is economically additional to the baseline. If not, the JI project is not economically additional.

Slide 36

Determining the GHG Additionality of a Project

- GHG Additionality – define the net greenhouse gas (GHG) emissions for the JI and the baseline project. Determine if the GHG emissions for the JI project are less than the GHG emissions for the baseline project. That is: $GHG_{JI} < GHG_b$.
  - If not, the JI project is not environmentally additional to the baseline project.
- ERs of the JI Project – the emission reductions (ERs) of the JI project can simply be represented as:
  - $ER_{JI} = GHG_b - GHG_{JI}$.

Slide 37

Determining the Cost Effectiveness of JI Projects

- The financial cost effectiveness (FEC_{JI}) of GHG mitigation for a JI project is simply:

$$FEC_{JI} = (FPVC_{JI} - FPVC_b)/ER_{JI}$$

- The economic cost effectiveness (EEC_{JI}) of GHG mitigation for a JI project is simply:

$$EEC_{JI} = (EPVC_{JI} - EPVC_b)/ER_{JI}$$

- The resulting cost effectiveness of GHG is represented by:
  - \$/ton CO_2 equivalent mitigated.

Slide 38

Financial and Economic Assessments of Projects (part II)

Session 18

Module 2: Economics of Climate Change

Slide 1

Capital Outlays and Financing Structure/Sources

- Project Investment Breakdown Schedule (Use of Proceeds)
- Capital Structure and Sources of Funding
- Financial "Additionality"

Slide 2

Project Investment Breakdown Schedule (Use of Proceeds)

Item	Local Currency	Foreign Currency	Date and comments
Start-up expenses			
Land			
Interest during construction			
Equipment & Machinery			
Training & testing			
Incremental portion attributed to GHG avoidance			
Grand Total			

Slide 3

Project Investment Breakdown Schedule (Use of Proceeds)

Other Items to be included:

- land
- site preparation
- building
- installation and start-up
- inventory
- receivables and other working capital

Slide 4

Capital Structure and Sources of Funding

Class of funding and named source	Local currency	Foreign currency	Loan duration	Interest rate	Security/ collateral
Paid in equity					
-- Local project proponent					
-- Foreign expert					
-- International finance					
Short-term lines					
Long-term lines					
Totals					

Slide 5

Capital Structure and Sources of Funding

- Short-term lines:
  Leading local bank
  Equipment supplier
  Export credit line/co-financing
- Long-term lines:
  Local bonds
  Special JI/AIJ financing
- WB/Regional Development Bank financing

Slide 6

Financial "Additionality"

- The financing of JI/AIJ projects (or incremental components of larger projects) be additional to the official development assistance (ODA)
- Enhancing a project proposal in the identification or development stage by adding a discrete new component (sub-project) funded by a new and additional funding is within the spirit of the Convention

Slide 7

Income Stream and Key Assumptions

Critical not to overestimate income

The income stream of a IJ/AIJ venture would normally include at least two major components:

- Income from sale of energy such as electricity and heat supplied or saved
- Income from sales of GHG "credits" to the head office, partner or third party

Slide 8

Expense Projections

- Rough estimates of different categories of expenses
- Breakdown of operating expenses, e.g. by major category, such as labor , raw material, transport, utilities, sales/administration and taxes
- Margin and break-even analysis
- Transaction costs
- Cost-effectiveness of JI/AIJ, e.g. the relative cost of avoiding CO_2 in the host country

Slide 9

Cash Flow Analysis

- Cash Flow Projections
- Net Present Value
- Internal Rate of Return

Slide 10

Present Value Concept

Year end	Cashed Rec'd	PV @10%	PV@15%	PV@20%
1	100,000	90,909	86,957	83,333
2	100,000	82,645	75,614	69,444
3	100,000	75,131	65,752	57,870
.....				
10	100,000	38,554	24,718	16,151
Total Rec'd	1,000,000			
Present Value		614,457 @10%	501,877 @15%	419,247 @20%

Slide 11

Cash Flow Projections

	Category	Year 0	Year 1	Year 2	Year 3	Year ...
In (+)	Product sold					
	Waste sold					
	GHG credits					
Out (-)	Start-up					
	Machinery					
	Supply					
Net						

Slide 12

Sensitivity Analysis

Sensitivity Analysis is a simulation study of the **effect of changes** in critical planning assumptions and/or projections such as sales, cost of equipment, level of expense, and revenue starting date **on the financial viability** of the project

Slide 13

Project's IRR Sensitivity to Changes in the Level of Income

Year end	Cash out	Cash in Scenario A	Cash in Scenario B	Cash in Scenario C
0	(1,000,000)			
1		150,000	200,000	250,000
.....				
10		150,000	200,000	250,000
Totals	(1,000,000)	1,500,000	2,000,000	2,500,000
Net Present Value @ 15%		(214,943)	278	221,471
Internal Rate of Return		IRR of the Cash Flow=8%	IRR of the Cash Flow=15%	IRR of the Cash Flow=21%

Slide 14

Training Module Evaluation Form

Title of Module: Economics of Climate Change

Date: Module # 2

For each statement below, mark the circle on the scale that corresponds to your opinion.

		Evaluation score					
		1	2	3	4	5	
1. The presentation of this module was	Unclear	O	O	O	O	O	Clear
2. The objectives of this module were	Not important	O	O	O	O	O	Important
3. The information presented in this module was	Not sufficient	O	O	O	O	O	Sufficient
4. The information presented in this module was	Not useful	O	O	O	O	O	Useful
5. The exercises in this module were	Not interesting	O	O	O	O	O	Interesting
6. The knowledge acquired through this module was	Insignificant	O	O	O	O	O	Important
7. Participating in this module enable you to learn	Nothing new	O	O	O	O	O	Many new things

What did you like most about this module? _____

_____

What did you like least about this module? _____

_____

What is your opinion on presenters? _____

_____

What is your opinion on organization of this module? _____

_____

On what themes presented in the module would you like to get more information? _____

What module themes would be interesting for you in the future? _____

Comments: _____